Elegant Experiments

Practical Science made easy for teachers and students.
Chemistry, Physics, Biology and Geology for junior and senior school science.

Volume III

By Greg Reid

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Volumes I and II form a complete nucleus for high school science.
Volume III will be available in 1999 and will contain unusual experiments and added variety.
Further copies can be obtained at $45 per volume, orders to:

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PO Box222
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NSW, 2480

USING THIS BOOK

These books are intended as a user friendly resource for teachers to encourage "hands on science". The experiments can easily be incorporated when developing new programs, responding to a new syllabus or to enrich current programs.

While handing photocopy experiments to students may seem too easy, there are advantages beyond time saved to teachers. I have found that writing up lengthy procedures merely fragments student topic notes and the time consumed in writing directions often means the activity is rushed with conclusions poorly addressed.

EXPERIMENTS

The experiments are listed alphabetically by name to make them easy to find, however I draw your attention to the INDEX BY TOPIC at the end of the book. The topic index covers both volumes and lists experiment names under topics to which they are related. The purpose of the topic index is so you can quickly find experiments relating to a particular area of study. Rather than complicate the index by duplicating junior and senior topics, common topics appear only once with both junior and senior experiments appearing below.

If you have any good experiments not appearing here, please write to me and I will try to ensure ensure they are available to the struggling new generation of teachers.

TEACHER COPY

This copy includes related science topics, hints, controls, expected results, example conclusion, diagram , and risk assessment.

STUDENT COPY

This copy has space for written results and conclusions. Diagrams are included if the instructions are not sufficiently clear, otherwise the students should draw the equipment or use the space for a results table. A risk assessment is not included since this may unduly alarm some students and parents. The teacher should read the risk assessment to the class before beginning the experiment.

EQUIPMENT

I have tried to include <u>all</u> the equipment needed in each experiment. Concentrations are given in percentages so you are not constantly stopping to calculate molarities.

The following guides might help:

1/ The equipment list is based on items required by one group.

2/ Any chemical listed with a concentration is a stock solution that must be prepared. In the case of concentrated acids with density and strength corrections the following applies;

Hydrochloric acid, 370g/litre	1Molar = 10%
Sulfuric Acid, 98%, 1.84g/ml density,	1Molar = 5.4%
Nitric Acid, 70%, 1.42g/ml density,	1Molar = 6.3%
Phosphoric acid, 85%, 1.69g/ml density	1Molar = 6.8%
Ethanoic Acid (Glacial Acetic) 99%,	1Molar = 6.6%

3/ Any chemicals without a concentration means simply a class supply.

4/ Please read the risk assessment for your own protection during preparation and DISPOSAL.

5/ I recommend that you photocopy the Teacher Copies and place them in plastic sleeves in a ring folder.

Please feel free to write to me with any suggested improvements and any new experiments would be most welcome.

RISK ASSESSMENT

Every experiment has certain risks, not just from chemicals and equipment but from the unpredictable nature of students. In my years of teaching I have seen some remarkably stupid things such as a student attempting to "snort" citric acid or another trying a sucking contest wth a vacuum cleaner. With this in mind my classification of risk is based on chemical toxicity and exposure (following the new lists), except where the "student factor" seems a greater hazard. Of course professional judgment is needed. Some junior classes can be trusted with delicate equipment while others cannot be trusted with a pair of scissors. However as a general guide:

Low Hazard - Junior Classes

Mild Hazard - Junior classes with close supervision.

Moderate Hazard - Senior classes

HAZARDOUS - Teacher demonstration only.

Remember , familiarity often breeds contempt. Chemicals that are used often may be more toxic than you realise. For example cobalt chloride is a suspected carcinogen with an LD50 of 80mg/kg and and has been deleted from junior experiments in these books. By comparison, copper sulfate, a very commonly used laboratory chemical, has an LD50 of only 300mg/kg. Phenol has the same toxicity yet I am sure you are much more cautious of phenol than you are of copper sulfate. By contrast, lead nitrate is not overly toxic but is dangerous due to its accumulation from repeated small exposures.

PRACTICAL ASSESSMENT SUGGESTIONS

1/ A list of controlled experiments appears in the topic index. Ask your students to identify the appropriate control in each of these experiments.

2/ Collect student work sheets at random and apply a standard marking scale eg. records (4marks), observations (2marks), results (2marks), and conclusion (2marks). This should make the students take practical work seriously, encouraging participation, accurate records and a deductive conclusion (too often neglected).

3/ Record anecdotal marks as the students perform the experiment, focusing on equipment recognition, reading instructions and complete notes.

STUDENT:____________________

201 A Scientists Eyes

Aim: To observe closely and see beyond the obvious.

Equipment

A house candle

Alfoil squares, 10X10cm, 3

Procedure

Late last century, Michael Faraday revolutionised the world by discovering how to make electricity using magnets. His success was owed much to careful observation. He once made 53 observations of a candle flame.

1/ Light a candle and fix it upright on the square of alfoil with some melted wax.

2/ Closely observe the flame. On a page in your book record what you notice about the shape, location, structure, colour and behaviour of the flame.

3/ Closely observe the wick. Record what you notice about its colour, position and rate of burning.

4/ Closely observe the wax. Record what you notice about the state and flow of the wax.

5/ Closely observe the air above the candle flame. Record what you notice about the movement and smoke above the flame. Hold a peice of alfoil 10cm above the flame and record any changes.

6/ Place an alfoil tube around the candle flame and note any change.

- Predict what would happen if the candle were narrow like a a birthday candle.
- Predict what would happen if the candle was very broad.
- Predict what might happen when a broad candle is moved.
- Predict what would happen if the wick ran up one side instead of through the centre.
- Given the same amount of wax, which would burn longest, a very tall and thin candle or a short and fat candle?
- What is the advantage of a candle of medium thickness?

Results: ____

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Conclusion: ____

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TEACHER COPY

201

A Scientists Eyes

Topics: Scientific Method

Aim: To observe closely and see beyond the obvious.

Equipment

A house candle
Alfoil squares, 10X10cm, 3

Procedure

Late last century, Michael Faraday revolutionised the world by discovering how to make electricity using magnets. His success was owed much to careful observation. He once made 53 observations of a candle flame.

1/ Light a candle and fix it upright on the square of alfoil with some melted wax.

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3/ Closely observe the wick. Record what you notice about its colour, position and rate of burning.

4/ Closely observe the wax. Record what you notice about the state and flow of the wax.

5/ Closely observe the air above the candle flame. Record what you notice about the movement and smoke above the flame. Hold a piece of alfoil 10cm above the flame and record any changes.

6/ Place an alfoil tube around the candle flame and note any change.

- Narrow candles burn quickly as most of the wax is lost down the sides.
- Broad candles develop a sunken pool of melted wax and burn slowly.
- When moved, broad candles go out as the pool of wax floods the flame.
- A wick at the side would rapidly burn down.
- Thick candles last longer than thin candles.
- Medium candles optimise portability and burning time.

Result: The flame burns around the wick a short distance above the melted wax. The wick does not appear to burn. Convection currents of warm air above the flame carry soot which condenses onto objects.

Conclusion: The flame is burning wax vapours drawn up the wick from the pool of melted wax below. NOTE: In zero gravity there are no convection currents. The flame would be spherical, the candle would not drip but melt rapidly, the liquid wax tending to flow up the wick and flooding the flame. All circuits in zero gravity must be cooled by fans or radiation.

Risk Level: Low Hazard: Some minor burns are to be expected from hot wax .

STUDENT:____________________

202 # Aims

Aim: ____

Equipment

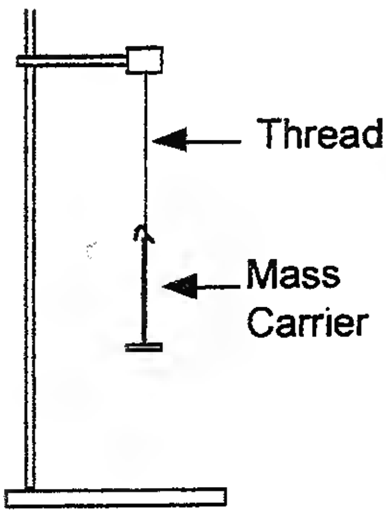
Retort Stand
Boss head and clamp
Cotton thread, gauge 1,
Rubber Band, Gauge 11
Mass Carrier
Masses, 50g, six

Procedure

A single experiment can only answer a restricted "Aim".
Perform the following procedure:

1. Tie a thread of cotton to hang from a clamp on a retort stand.
2. Tie a mass carrier to the other end of the thread
3. Add masses to the carrier and record the total mass which breaks the thread. ________g
4. Replace the cotton thread with a rubber band (gauge 11).
5. Add masses and record the total mass which breaks the rubber band. ______g

- Does this experiment show that rubber is stronger than any thread? ___________
- Does this experiment show that rubber is stronger than cotton? _________
- Does this experiment show that all rubber bands are stronger than all cotton thread? ______
- Does this experiment show that a gauge 11 rubber band is stronger than a gauge 1 cotton thread? ______



- Next to the heading "Aim" at the top of this page, write a sentence which accurately states what this experiment might prove.

Results: ____

____

____

Conclusion: ____

____

____

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TEACHER COPY

202

Aims

Topics: Scientific Method Forces

Aim: ____

Equipment

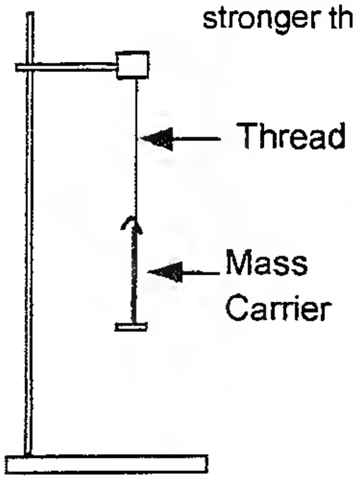
Retort Stand
Boss head and clamp
Cotton thread, gauge 1,
Rubber Band, Gauge 11
Mass Carrier
Masses, 50g, six

Procedure

A single experiment can only answer a restricted "Aim". Perform the following procedure:

1. Tie a thread of cotton to hang from a clamp on a retort stand.
2. Tie a mass carrier to the other end of the thread
3. Add masses to the carrier and record the total mass which breaks the thread. ________g
4. Replace the cotton thread with a rubber band (gauge 11).
5. Add masses and record the total mass which breaks the rubber band. ______g

- Does this experiment show that rubber is stronger than any thread? __________
- Does this experiment show that rubber is stronger than cotton? ________
- Does this experiment show that all rubber bands are stronger than all cotton thread? ______
- Does this experiment show that a gauge 11 rubber band is stronger than a gauge 1 cotton thread? ______



- Next to the heading "Aim" at the top of this page, write a sentence which accurately states what this experiment might prove.

Result: Less mass was required to break the cotton thread than the rubber band.

Conclusion: A Gauge 11 rubber band can usually support more weight than a gauge 1 cotton thread.

Risk Level: Low Hazard;

STUDENT:____________________

203

Procedure

Aim: To find the flaws in the procedure below designed to compare a laundry powder and a liquid detergent.

Equipment

Laundry powder
Liquid Detergent
Beakers, 250ml, two
Mixed rags
Water supply, hot or cold
stopwatch
stirring rod
Stains: Tomato sauce
Soy sauce
Sump oil

Procedure

1/ Choose two rags and put on some stain.
2/ Add some water to two beakers.
3/ Add some laundry powder to one beaker.
4/ Add some liquid detergent to the other beaker.
5/ Place a stained rag in each beaker.
6/ After a while, remove the rags and see which is cleanest.

- Should the rags be identical?_____
- Should the cloth be white?______
- Should the same stain be tested on each rag?_____
- Should the same amount of water be in each beaker? ____
- Did you use hot or cold water? ____
- List three other factors that should be the same and should have been mentioned.

a)____________________
b)____________________
c)____________________

Results: ____

____

____

Conclusion: ____

____

____

____

TEACHER COPY

203

Procedure

Topics: Scientific Method Consumer Science

Aim: To find the flaws in the procedure below designed to compare a laundry powder and a liquid detergent.

Equipment

Laundry powder
Liquid Detergent
Beakers, 250ml, two
Mixed rags
Water supply, hot or cold
stopwatch
stirring rod
Stains: Tomato sauce
Soy sauce
Sump oil

Procedure

1/ Choose two rags and put on some stain.
2/ Add some water to two beakers.
3/ Add some laundry powder to one beaker.
4/ Add some liquid detergent to the other beaker.
5/ Place a stained rag in each beaker.
6/ After a while, remove the rags and see which is cleanest.

- Should the rags be identical?_____
- Should the cloth be white?______
- Should the same stain be tested on each rag?____
- Should the same amount of water be in each beaker? ____
- Did you use hot or cold water? ____
- List three other factors that should be the same and should have been mentioned.

a)__________________
b)__________________
c)__________________

Result: The result will vary depending on the stain and water temperature.

Conclusion: Many factors must be specified and equal in this experiment. The cloth should be white and the same material. The same stain should be tested and the water temperature must be the same. In addition, the amount used of each detergent should be stated, how long the washing proceeds and how the the cloth is agitated in the water.

Risk Level: Low Hazard; Some laundry powders are caustic and contact with the eyes should be treated by prolonged irrigation. Keep a close eye on the stains lest some smart student decide to "test" the uniform of another student.

STUDENT:____________________

204

Results

Aim: To correctly record the results of an experiment measuring the temperature changes in a reaction.

Equipment

Magnesium ribbon, 2cm
Test tube rack
Test tube, medium
Thermometer, 0-100
Graph paper
Hydrochloric acid,1M(10%)

Procedure

The results of an experiment should include any observations you have made and ideally some measurements. Measurements should be recorded in a table and then put into a graph which compares the figures with a variable such as time.

1/ In the space below draw up a table that will record a temperature every ten seconds from 0 to 120 seconds.
2/ Add 2cm of hydrochloric acid to a test tube in a test tube rack.
3/ Add a thermometer to the test tube and record the temperature.
4/ Add a 2cm length of magnesium ribbon to the tube.
5/ Record the temperature every 10 seconds for two minutes
6/ Make notes of any observations beside your table.
7/ Use the graph paper to draw up a line graph of the temperature readings versus time.
8/ In the "Results" space below, write a brief summary of your observations and the pattern of temperature change.

Results: ____

____

____

Conclusion: ____

____

____

____

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204

Results

Topics: Scientific Method Exothermic

Aim: To correctly record the results of an experiment measuring the temperature changes in a reaction.

Equipment

Magnesium ribbon, 2cm
Test tube rack
Test tube, medium
Thermometer, 0-100
Graph paper
Hydrochloric acid,1M(10%)

Procedure

The results of an experiment should include any observations you have made and ideally some measurements. Measurements should be recorded in a table and then put into a graph which compares the figures with a variable such as time.

1/ In the space below draw up a table that will record a temperature every ten seconds from 0 to 120 seconds.
2/ Add 2cm of hydrochloric acid to a test tube in a test tube rack.
3/ Add a thermometer to the test tube and record the temperature.
4/ Add a 2cm length of magnesium ribbon to the tube.
5/ Record the temperature every 10 seconds for two minutes
6/ Make notes of any observations beside your table.
7/ Use the graph paper to draw up a line graph of the temperature readings versus time.
8/ In the "Results" space below, write a brief summary of your observations and the pattern of temperature change.

Result: Magnesium reacts with hydrochloric acid, gradually dissolving and liberating bubbles of colourless gas. The temperature of the acid rose rapidly, gradually reached a plateau as the reaction ended, and then fell slowly.

Conclusion: Heat energy liberated in the reaction increased the temperature of the acid at a relatively constant rate until the supply of reactants became limiting. In this case the surface area of the magnesium ribbon decreased as it dissolved and this slowed the reaction rate. When the reaction ceased, heat loss to the surroundings caused a slow decline in temperature.

Risk Level: Low Hazard: Hydrochloric acid 1M is mildly corrosive and any contact with skin should be washed with water. The reaction produces hydrogen gas which is explosive if allowed to accumulate.

STUDENT:________________

205 Conclusion

Aim: To write a conclusion for an experiment investigating the relationship between resistance and current in a circuit.

Equipment

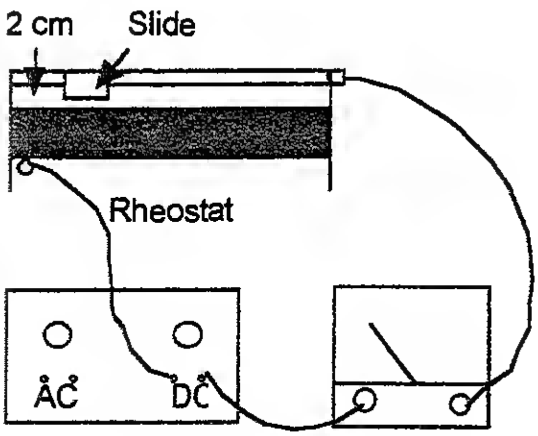
Rheostat, 10 ohm
Power supply, 0-12V DC.
Ammeter, 0-5A
Connecting wires, three

Note: The rheostat is a coil of resistance wire. As the slide is moved, resistance increases.

Procedure

The conclusion of an experiment has several roles:
- It must state whether the aim of the experiment was achieved.
- It will attempt to explain what happened in the experiment.
- It may suggest improvements or new experiments to continue the investigation.

1/ Set the power supply to 4 Volts DC.
2/ Connect the negative DC terminal to the rheostat.
3/ Connect the slide bar terminal of the rheostat to the negative terminal of the ammeter.
4/ Connect the positive terminal of the ammeter to the positive DC terminal of the power supply.
5/ Move the rheostat slide to opposite end from the connecting wire, then move it back 2cm.
6/ Turn on the power and record the meter reading.
7/ Move the slide another 2cm and record the meter reading.
8/ Continue until the slide reaches the other end.
9/ Draw a graph of Resistance (cm.) versus Current (amps).



Resist. (cm)	Current (amps)
2cm	
4cm	
6cm	
8cm	
10cm	
12cm	
14cm	

Results: ________________________________

Conclusion: ________________________________

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205

Conclusion

Topics: Scientific Method Electricity

Aim: To write a conclusion for an experiment investigating the relationship between resistance and current in a circuit.

Equipment

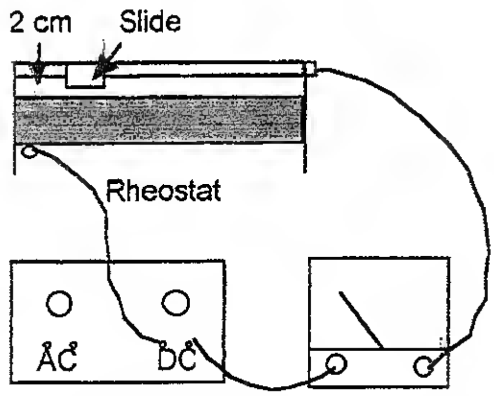
Rheostat, 10 ohm
Power supply, 0-12V DC.
Ammeter, 0-5A
Connecting wires, three

Note: The rheostat is a coil of resistance wire. As the slide is moved, resistance increases.

Procedure

The conclusion of an experiment has several roles:
- It must state whether the aim of the experiment was achieved.
- It will attempt to explain what happened in the experiment.
- It may suggest improvements or new experiments to continue the investigation.

1/ Set the power supply to 4 Volts DC.
2/ Connect the negative DC terminal to the rheostat.
3/ Connect the slide bar terminal of the rheostat to the negative terminal of the ammeter.
4/ Connect the positive terminal of the ammeter to the positive DC terminal of the power supply.
5/ Move the rheostat slide to opposite end from the connecting wire, then move it back 2cm.
6/ Turn on the power and record the meter reading.
7/ Move the slide another 2cm and record the meter reading.
8/ Continue until the slide reaches the other end.
9/ Draw a graph of Resistance (cm.) versus Current (amps).



Resist. (cm)	Current (amps)
2cm	
4cm	
6cm	
8cm	
10cm	
12cm	
14cm	

Result: As resistance increased the current in the circuit decreased. A graph of resistance versus current was found to be a curve.

Conclusion: Resistance and Current appear to be inversely related. Increasing the resistance in a circuit restricts the current that can flow at a given voltage. The experiment should be repeated for different voltages and graphs drawn relating voltage and amperage at particular resistances.

Risk Level: Low Hazard

STUDENT: ____________________

206

Controls

Aim: To identify the importance of a control in an experiment testing lead contamination in water samples.

Equipment

Test Tube Rack
Test tubes, medium, five
Sodium Iodide, 0.1% in a Dropper bottle.
Lead Nitrate, 0.1%
Soil Water (Filtrate of 10g soil & 200ml water).
Pond Water
Road Water (from a bitumen puddle)

Procedure

In an experiment all the factors which might affect the experiment are kept constant except for the one variable being tested. Many factors are difficult or impossible to keep constant eg temperature, humidity, wind, sunshine. The effect of these variables can be eliminated by using a "control", that is, a part of your experiment identical to the rest except for the test variable.

1/ Place five test tubes in a test tube rack.
2/ Add 2cm of tap water to the first tube, 2cm of soil water to the second tube, 2cm of pond water to the third tube, 2cm of road water to the fourth tube and 2cm of Lead solution to the last tube.
3/ Add 10 drops of sodium iodide solution to each tube.
4/ Record your results in the table below.
- Which tube is the negative control (showing the that no reaction occurs if lead is not present).
- Which tube is the positive control (showing a particular reaction when lead is known to be present).

Test Tube	Reaction with sodium iodide
1	
2	
3	
4	
5	

Results: ____

____

____

Conclusion: ____

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206

Controls

Topics: Scientific Method Water Chem Tests

Aim: To identify the importance of a control in an experiment testing lead contamination in water samples.

Equipment

Test Tube Rack
Test tubes, medium, five
Sodium Iodide, 0.1% in a Dropper bottle.
Lead Nitrate, 0.1%
Soil Water (Filtrate of 10g soil & 200ml water).
Pond Water
Road Water (from a bitumen puddle)

Water samples may be simulated with a pinch of clay, and road water simulated with a 1:10 dilution of lead nitrate soln.

Procedure

In an experiment all the factors which might affect the experiment are kept constant except for the one variable being tested. Many factors are difficult or impossible to keep constant eg temperature, humidity, wind, sunshine. The effect of these variables can be eliminated by using a “control”, that is, a part of your experiment identical to the rest except for the test variable.

1/ Place five test tubes in a test tube rack.
2/ Add 2cm of tap water to the first tube, 2cm of soil water to the second tube, 2cm of pond water to the third tube, 2cm of road water to the fourth tube and 2cm of Lead solution to the last tube.
3/ Add 10 drops of sodium iodide solution to each tube.
4/ Record your results in the table below.

- Which tube is the negative control (showing the that no reaction occurs if lead is not present).
- Which tube is the positive control (showing a particular reaction when lead is known to be present)

Test Tube	Reaction with sodium iodide
1	
2	
3	
4	
5	

Result: The fourth and fifth test tubes produced a bright yellow precipitate.

Conclusion: Sodium iodide produces a bright yellow precipitate with lead ions. The road water sample produces a precipitate due to residues from leaded petrol. The first test tube is a negative control and the last test tube a positive control.

Risk Level: Moderate Hazard: Lead nitrate is a cumulative toxin and contact should be avoided. Sodium iodide may be irritating to skin and is harmful if ingested in quantity. Reagents may be disposed down the sink with flushing.

STUDENT:______________________

207 Variables & Constants

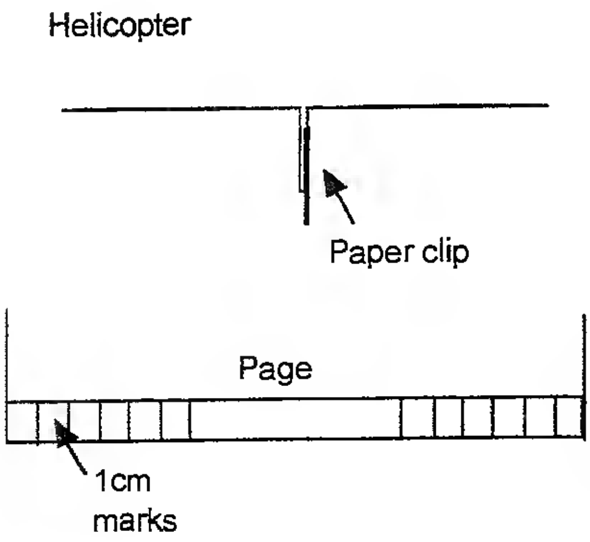
Aim: To identify the factors which are constants and the factors which are variables in an experiment comparing paper helicopters.

Equipment

Stop watch
Scissors
Paper clip

Procedure

1/ Rule a line across the bottom of this page, 1.5 cm from the bottom edge.
2./ Draw vertical lines on this strip marking 6cm from each side edge. Continue making vertical lines for each centimetre to the edge on each side.
3/ Cut the strip from the bottom of the page.
4/ Fold the strip in half.
5/ Fold 8cm of each half back to make a broad "T"
6/ Attach a paper clip to the vertical centre piece.
7/ Stand on a seat holding your helicopter at the top of your reach.
8/ Use the stop watch to time how long the helicopter takes to fall to the floor. Record the result in the table.
9/ Cut 1 cm off each wing and repeat step 8.
10/ Repeat step 9, five times.
-From the following list, which have been kept constant?
Width of the strip, height above the floor, wing length, weight, type of paper.
- Which item in the list was the variable being tested?



Wing Length	Fall Time
8cm	
7cm	
6cm	
5cm	
4cm	
3cm	
2cm	

Results: ____

____

____

Conclusion: ____

____

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TEACHER COPY

207

Variables & Constants

Topics: Scientific Method Flight

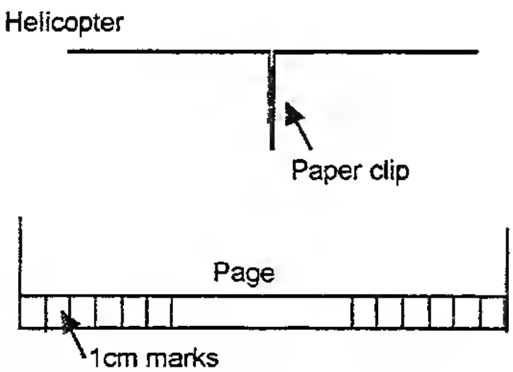
Aim: To identify the factors which are constants and the factors which are variables in an experiment comparing paper helicopters.

Equipment

Stop watch
Scissors
Paper clip

Procedure

1/ Rule a line across the bottom of this page, 1.5 cm from the bottom edge.
2./ Draw vertical lines on this strip marking 6cm from each side edge. Continue making vertical lines for each centimetre to the edge on each side.
3/ Cut the strip from the bottom of the page.
4/ Fold the strip in half.
5/ Fold 8cm of each half back to make a broad "T"
6/ Attach a paper clip to the vertical centre piece.
7/ Stand on a seat holding your helicopter at the top of your reach.
8/ Use the stop watch to time how long the helicopter takes to fall to the floor. Record the result in the table.
9/ Cut 1 cm off each wing and repeat step 8.
10/ Repeat step 9, five times.
-From the following list , which have been kept constant?
Width of the strip, height above the floor, wing length, weight, type of paper.
- Which item in the list was the variable being tested?



Wing Length	Fall Time
8cm	
7cm	
6cm	
5cm	
4cm	
3cm	
2cm	

Result: Time to fall decreases with wing length.

Conclusion: Factors which were held constant include: Wing width, paper type, height above the floor, and weight (since the paper clip greatly exceeds the weight of the paper).
The variable factor being tested in this experiment was wing length.

Risk Level: Low Hazard:

STUDENT:________________

208

Graphs 1

Aim: To convert tabulated data into a graph from which trends may be recognised.

Equipment **Procedure**

1/ Subtract the lowest figure from the highest figure in the first column. The difference between these two figures must fit on the horizontal axis of your graph. If the difference is 12, 120 or 12000 draw a line 12cm long on the bottom of the graph paper. If the difference is a number like 3, 30 or 3000 draw a line 3 or 4 times longer than 3cm so your graph is not too small.

2/ Mark the left hand end of the line with the lowest figure and the right hand end of the line with the highest figure.

3/ Divide the line into equal lengths which correspond to ones, tens or thousands depending on what you need.

4/ Label the divisions you have made and write below what the numbers stand for eg. Temperature (centigrade).

5/ Repeat steps 1 to 4 for the next column of the table, this time making a vertical line at the left of the page.

6/ Look at the first number in column one. Find the position of this number on the bottom line of the graph. Place your ruler vertically marking this position.

7/ Look at the first number in column two. Find the position of this number on your line at the left of the graph. Mark a dot on the graph, next to your ruler and which is level with the position you found.

8/ Repeat steps 6 and 7 for each of the numbers in the table.

9/ Join the dots on your graph.

10/ Describe the graph in the "Results" and what it means in the "Conclusion".

Heating Time (minutes)	Temperature Centigrade
0	20
1	35
2	50
3	65
4	80
5	80
6	80

Temperature of napthalene with continous heating.

Results: ____

____

____

Conclusion: ____

____

____

____

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208

Graphs 1

Topics: Scientific Method

Aim: To convert tabulated data into a graph from which trends may be recognised.

Equipment **Procedure**

1/ Subtract the lowest figure from the highest figure in the first column. The difference between these two figures must fit on the horizontal axis of your graph. If the difference is 12, 120 or 12000 draw a line 12cm long on the bottom of the graph paper. If the difference is a number like 3, 30 or 3000 draw a line 3 or 4 times longer than 3cm so your graph is not too small.

2/ Mark the left hand end of the line with the lowest figure and the right hand end of the line with the highest figure.

3/ Divide the line into equal lengths which correspond to ones, tens or thousands depending on what you need.

4/ Label the divisions you have made and write below what the numbers stand for eg. Temperature (centigrade).

5/ Repeat steps 1 to 4 for the next column of the table, this time making a vertical line at the left of the page.

6/ Look at the first number in column one. Find the position of this number on the bottom line of the graph. Place your ruler vertically marking this position.

7/ Look at the first number in column two. Find the position of this number on your line at the left of the graph. Mark a dot on the graph, next to your ruler and which is level with the position you found.

8/ Repeat steps 6 and 7 for each of the numbers in the table.

9/ Join the dots on your graph.

10/ Describe the graph in the "Results" and what it means in the "Conclusion".

Result: Temperature increases with heating time until 80 degree centigrade after which the temperature remains constant.

Conclusion: The melting point of napthalene is 80 degrees centigrade.

Risk Level: Low Hazard.

STUDENT:________________

209 Graphs 2

Aim: To convert tabulated data into a graph from which trends may be recognised.

Equipment **Procedure**

1/ Subtract the lowest figure from the highest figure in the first column. The difference between these two figures must fit on the horizontal axis of your graph. If the difference is 12, 120 or 12000 draw a line 12cm long on the bottom of the graph paper. If the difference is a number like 3, 30 or 3000 draw a line 3 or 4 times longer than 3cm so your graph is not too small.
2/ Mark the left hand end of the line with the lowest figure and the right hand end of the line with the highest figure.
3/ Divide the line into equal lengths which correspond to ones, tens or thousands depending on what you need.
4/ Label the divisions you have made and write below what the numbers stand for eg. Temperature (centigrade).
5/ Repeat steps 1 to 4 for the next column of the table, this time making a vertical line at the left of the page.
6/ Look at the first number in column one. Find the position of this number on the bottom line of the graph. Place your ruler vertically marking this position.
7/ Look at the first number in column two. Find the position of this number on your line at the left of the graph. Mark a dot on the graph, next to your ruler and which is level with the position you found.
8/ Repeat steps 6 and 7 for each of the numbers in the table.
9/ Join the dots on your graph.
10/ Describe the graph in the "Results" and what it means in the "Conclusion".

Temperature Centigrade	Height Kilometres
-100	80
0	0
-50	10
200	130
-80	100
0	50
-50	70

Variation of temperature in the Atmosphere with height above the ground.

Results: ____

____

____

Conclusion: ____

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209

Graphs 2

Topics: Scientific Method Atmosphere

Aim: To convert tabulated data into a graph from which trends may be recognised.

Equipment **Procedure**

1/ Subtract the lowest figure from the highest figure in the first column. The difference between these two figures must fit on the horizontal axis of your graph. If the difference is 12, 120 or 12000 draw a line 12cm long on the bottom of the graph paper. If the difference is a number like 3, 30 or 3000 draw a line 3 or 4 times longer than 3cm so your graph is not too small.

2/ Mark the left hand end of the line with the lowest figure and the right hand end of the line with the highest figure.

3/ Divide the line into equal lengths which correspond to ones, tens or thousands depending on what you need.

4/ Label the divisions you have made and write below what the numbers stand for eg. Temperature (centigrade).

5/ Repeat steps 1 to 4 for the next column of the table, this time making a vertical line at the left of the page.

6/ Look at the first number in column one. Find the position of this number on the bottom line of the graph. Place your ruler vertically marking this position.

7/ Look at the first number in column two. Find the position of this number on your line at the left of the graph. Mark a dot on the graph, next to your ruler and which is level with the position you found.

8/ Repeat steps 6 and 7 for each of the numbers in the table.

9/ Join the dots on your graph.

10/ Describe the graph in the "Results" and what it means in the "Conclusion".

Result: Temperature falls with increasing height to 10km then rises to 50km. Temperature falls again with increasing height to 80km then increases to 130km.

Conclusion: Temperature decreases with increasing height in two regions of the atmosphere, 0 - 10km and 50 - 80km. Elsewhere the temperature in the atmosphere increases with height. There is no simple relationship between height and temperature.

Risk Level: Low Hazard.

STUDENT: ____________________

210 # Hypothesis

Aim: To write a good hypothesis.

Equipment **Procedure**

An "Aim " for an experiment is a statement of what you hope an experiment will determine. The most common flaw in an "Aim" is that it is too general eg. " To determine whether manure is the best fertiliser." Such an aim will require not only comparing all possible fertilisers but also measuring their effect on all known plants in all possible conditions. An "Aim" actually possible in a single experiment would be " To determine whether manure produces better growth in lima beans compared to the same weight of 'grow plus' fertiliser."

An Hypothesis is an aim stated in a form which predicts an outcome eg. " Manure produces better growth in lima beans than the same weight of 'grow plus' fertiliser."

Rewrite each of the following "Aims" as a "Hypothesis" .

Aim: To determine if the North poles of magnets repel each other.

Hypothesis: ____

____

Aim: At what temperature does water boil?

Hypothesis: ____

Aim : To find which ball point pen writes longest.

Hypothesis: ____

____

Aim: To determine whether soap is better than detergent.

Hypothesis: ____

____

Results: ____

____

____

Conclusion: ____

____

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____

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210

Hypothesis

Topics: Scientific Method

Aim: To write a good hypothesis.

Equipment **Procedure**

An "Aim " for an experiment is a statement of what you hope an experiment will determine. The most common flaw in an "Aim" is that it is too general eg. " To determine whether manure is the best fertiliser." Such an aim will require not only comparing all possible fertilisers but also measuring their effect on all known plants in all possible conditions. An "Aim" actually possible in a single experiment would be " To determine whether manure produces better growth in lima beans compared to the same weight of 'grow plus' fertiliser."

An Hypothesis is an aim stated in a form which predicts an outcome eg. " Manure produces better growth in lima beans than the same weight of 'grow plus' fertiliser."

Rewrite each of the following "Aims" as a "Hypothesis" .

Aim: To determine if the North poles of magnets repel each other.

Hypothesis:____

____

Aim: At what temperature does water boil?

Hypothesis: ____

Aim : To find which ball point pen writes longest.

Hypothesis:____

____

Aim: To determine whether soap is better than detergent.

Hypothesis:____

____

Result: To be left blank.

Conclusion: The North Poles of magnets repel each other. Water boils at 100 degrees centigrade. Brand "X" pen writes longer than other ball point pens. Brand "Y" soap is better for washing grease from dishes in hot water than brand "Z" detergent.

Risk Level: Low Hazard

STUDENT:____________________

211 Parameters

Aim: To select the correct parameter to measure in an experiment examining short term memory.

Equipment

Photocopy of a page from the telephone directory.

Procedure

A Parameter is something which can be measured. In an experiment you should choose a parameter which is clearly related to the subject of your experiment. For example; When measuring growth in clover, height is not a good parameter, leaf width however, closely matches growth of the plant.

Perform the following experiment in pairs.

1/ The student acting as experimenter reads the <u>last</u> six digits of a telephone number to the other student.

2/ The student acting as the subject must count five seconds then repeat the number. Record the result in the table below.

3/ Another six digit number is read but this time the subject must count to ten before repeating the number.

4/ Repeat the procedure increasing the count by five each time until the wait time reaches 50.

- Which parameter was a better measure of short term memory, all correct or number of digits correct.

Wait Time (secs)	Correct (yes or no)	Number of Digits Correct
5		
10		
15		
20		
25		
30		
35		
40		
45		
50		

Results: ____

____

____

Conclusion: ____

____

____

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211

Parameters

Topics: Scientific Method

Aim: To select the correct parameter to measure in an experiment examining short term memory.

Equipment

Photocopy of a page from the telephone directory.

Procedure

A Parameter is something which can be measured. In an experiment you should choose a parameter which is clearly related to the subject of your experiment. For example; When measuring growth in clover, height is not a good parameter , leaf width however, closely matches growth of the plant.

Perform the following experiment in pairs.

1/ The student acting as experimenter reads the last six digits of a telephone number to the other student.

2/ The student acting as the subject must count five seconds then repeat the number. Record the result in the table below.

3/ Another six digit number is read but this time the subject must count to ten before repeating the number.

4/ Repeat the procedure increasing the count by five each time until the wait time reaches 50.

- Which parameter was a better measure of short term memory, all correct or number of digits correct.

Wait Time (secs)	Correct (yes or no)	Number of Digits Correct
5		
10		
15		
20		
25		
30		
35		
40		
45		
50		

Result: The subject could not repeat the whole number correct beyond 5 seconds but could remember some of the digits. The number of digits remembered decreased as the time interval lengthened.

Conclusion: Short term memory lasts only a few seconds before it begins to break down. In this experiment the "number of digits correct" is a better parameter to measure than "correct or incorrect". "Number of digits correct" actually shows some decay of memory over time whereas "correct or incorrect" shows no change beyond the shortest time intervals.

Risk Level: Low Hazard:

STUDENT:____________________

212

Replicates

Aim: To examine the importance of replicates in an experiment to determine the population density of ants.

Equipment

Wire square 20cm X 20cm

Procedure

In many experiments a variety of unknown factors may effect the measurements taken. Replicates means taking several measurements or to performing the experiment several times to be sure the results are reliable.

1/ Go to the school oval with your teacher.
2/ Drop the wire square on the ground.
3/ Carefully examine the area within the coat hanger and count the number of ants seen. Record the result in the table below.
4/ Move ten metres from your first position and repeat step 3.
5/ Repeat step 4 another three times.
6/ Calculate the average number of ants found and estimate the number of ants per square metre.

- List some reasons why your result may be different from other groups.
- What factors may influence the result if the counts were done at a different time or in a different place?
- How might a reliable figure be determined?

Area	Ants
1	
2	
3	
4	
5	
Total	
Average	

Area of Wire Square
= 0.04 sq metre

Ants per sq. metre
= Average X 25

= ____________

Results: ____

____

____

Conclusion: ____

____

____

____

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212

Replicates

Topics: Scientific Method Invertebrates

Aim: To examine the importance of replicates in an experiment to determine the population density of ants.

Equipment

Wire square 20cm X 20cm

- Coat hangers are easily made into wire square.

-The mass of ants on the Earth exceeds the mass of humans .

Procedure

In many experiments a variety of unknown factors may effect the measurements taken. Replicates means taking several measurements or to performing the experiment several times to be sure the results are reliable.

1/ Go to the school oval with your teacher.
2/ Drop the wire square on the ground.
3/ Carefully examine the area within the coat hanger and count the number of ants seen. Record the result in the table below.
4/ Move ten metres from your first position and repeat step 3.
5/ Repeat step 4 another three times.
6/ Calculate the average number of ants found and estimate the number of ants per square metre.

- List some reasons why your result may be different from other groups.
- What factors may influence the result if the counts were done at a different time or in a different place?
- How might a reliable figure be determined?

Area	Ants
1	
2	
3	
4	
5	
Total	
Average	

Area of Wire Square
= 0.04 sq metre

Ants per sq. metre
= Average X 25

= ____________

Result: The counts by each group will vary depending on whether any of their test areas were close to a nest.

Conclusion: Individual groups will have different results depending on their observation skills and nearness to ant nests. Ant numbers seen will vary with the seasons, weather, time of day, soil type and food supply in particular locations. A much larger survey including many measurements at many locations at a variety of times would be needed for a reliable average.

Risk Level: Low Hazard: Avoid known locations of aggressive ants.

STUDENT:________________

213

Sampling

Aim: To use proper sampling of a population to examine the hypothesis that teenage boys are generally taller than teenage girls.

Equipment

Tape measure
Note to show other teachers.

Procedure

To determine whether teenage boys are taller than teenage girls it will not be enough to compare the average height of both groups in your class. Firstly the sample must be representative eg. include all classes from year 7 to year 12. Secondly the sample must be random ie. students must be selected by a method not related to height.

1/ The teacher will give each group a note which explains your task to other teachers.

2/ The teacher will assign a classroom you are to check. If that room is empty try the room next door.

3/ Go to your assigned room, knock and wait.

4/ Show the teacher in that room your note and ask to measure the height of the first girl on the right side of the class and the first boy on the left side of the class.

5/ Record the results in the table below, return to your class and complete the table with the results from other groups.

- What might be wrong with your sample?
- Devise a plan to determine the number of stars in the sky.

Group	Class	Girls Height	Boys Height
1			
2			
3			
4			
5			
6			
	Average		

Results: ____

____

____

Conclusion: ____

____

____

____

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213

Sampling

Topics: Scientific Method

Aim: To use proper sampling of a population to examine the hypothesis that teenage boys are generally taller than teenage girls.

Equipment

Tape measure
Note to show other teachers.

Allocate only two elective classrooms as it is likely these will be occupied by one year group.

Procedure

To determine whether teenage boys are taller than teenage girls it will not be enough to compare the average height of both groups in your class. Firstly the sample must be representative eg. include all classes from year 7 to year 12. Secondly the sample must be random ie. students must be selected by a method not related to height.

1/ The teacher will give each group a note which explains your task to other teachers.
2/ The teacher will assign a classroom you are to check.
If that room is empty try the room next door.
3/ Go to your assigned room, knock and wait.
4/ Show the teacher in that room your note and ask to measure the height of the first girl on the right side of the class and the first boy on the left side of the class.
5/ Record the results in the table below, return to your class and complete the table with the results from other groups.
- What might be wrong with your sample?
- Devise a plan to determine the number of stars in the sky.

Group	Class	Girls Height	Boys Height
1			
2			
3			
4			
5			
6			
	Average		

Result: Older teenage boys are generally taller than girls but younger teenage boys are often shorter than girls the same age.

Conclusion: The sample size is too small to positively determine whether teenage boys are taller than teenage girls. To estimate the number of stars in the sky will require counting the stars in a telescope field then repeating this count in other fields **randomly** distributed but including **representative** samples in and out of the Milky Way. The average is then applied to the whole sky.

Risk Level: Low Hazard:

STUDENT:____________________

Blind Trial

Aim: To examine the effect of expectations on the result of an experiment.

Equipment

Dropper Bottles:
Sugar 1%
Sugar 0.1%
Sugar 0.01%
Salt 1%
Salt 0.1%
Salt 0.01%
Water

Blind Fold

Procedure

1/ One student in the group is chosen as a subject.
2/ Another student in the group will place a drop of one solution on the tongue of the subject.
3/ The subject reports whether the solution tastes sweet, salty or nothing. The response is recorded in the table below.
4/ Continue until all the solutions have been tasted.
5/ Blindfold the subject
6/ Repeat the taste test making sure the solutions are tasted in random order, that is without a pattern,not strong to weak or sweet to salt. You may present some solutions twice.
7/ Compare the results of test with and without the blindfold.

Solution	Taste (no blindfold)	Taste (blindfold)
Sugar 1%		
Sugar 0.1%		
Sugar 0.01%		
Water		
Salt 1%		
Salt 0.1%		
Salt 0.01%		

Results: ____

____

____

Conclusion: ____

____

____

____

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214

Blind Trial

Topics: Scientific Method Coordination

Aim: To examine the effect of expectations on the result of an experiment.

Equipment

Dropper Bottles:
Sugar 1%
Sugar 0.1%
Sugar 0.01%
Salt 1%
Salt 0.1%
Salt 0.01%
Water

Blind Fold

Procedure

1/ One student in the group is chosen as a subject.
2/ Another student in the group will place a drop of one solution on the tongue of the subject.
3/ The subject reports whether the solution tastes sweet, salty or nothing. The response is recorded in the table below.
4/ Continue until all the solutions have been tasted.
5/ Blindfold the subject
6/ Repeat the taste test making sure the solutions are tasted in random order, that is without a pattern,not strong to weak or sweet to salt. You may present some solutions twice.
7/ Compare the results of test with and without the blindfold.

NB: This experiment is a great way to compare "Coke" and "Pepsi".

Solution	Taste (no blindfold)	Taste (blindfold)
Sugar 1%		
Sugar 0.1%		
Sugar 0.01%		
Water		
Salt 1%		
Salt 0.1%		
Salt 0.01%		

Result: The subject was less accurate when blindfolded.

Conclusion: Without a blindfold the subject expected a certain taste from each solution and reported the correct response. This is called experiment bias or "placebo effect". With the blind fold and with solutions presented in random order the subject did not know what to expect and could not always correctly identify the weaker solutions.

Risk Level: Low Hazard: Beware of students fooling around when blind folded.

STUDENT:____________________

215

Double Blind Trial

Aim:

Equipment

Dropper Bottles:
Soln A
Soln B
Soln C
Soln D
Soln E
Soln F
Soln G

Blind fold

Procedure

1/ One student in the group is chosen as a subject.
2/ Another student in the group will place a drop of one solution on the tongue of the subject.
3/ The subject reports whether the solution tastes sweet, salty or nothing. The response is recorded in the table below. Do not taste the solution yourself until after the subject has reported.
4/ Continue until all the solutions have been tasted.
5/ Blindfold the subject.
6/ When the class has finished the taste test the teacher will write the identify the solutions on the board.
7/ Repeat the taste test.
8/ The teacher will tally the correct responses from each group for each solution, with and without the blindfold.
9/ Compare the tallies of correct responses.

Solution	Taste (no blindfold)	Tally	Taste (blindfold)	Tally
A				
B				
C				
D				
E				
F				
G				

Results: ____

____

____

Conclusion: ____

____

____

____

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215

Double Blind Trial

Topics: Scientific Method Coordination

Aim:

Equipment

Dropper Bottles:
Soln A
Soln B
Soln C
Soln D
Soln E
Soln F
Soln G

Blind fold

Procedure

1/ One student in the group is chosen as a subject.
2/ Another student in the group will place a drop of one solution on the tongue of the subject.
3/ The subject reports whether the solution tastes sweet, salty or nothing. The response is recorded in the table below. Do not taste the solution yourself until after the subject has reported.
4/ Continue until all the solutions have been tasted.
5/ Blindfold the subject.
6/ When the class has finished the taste test the teacher will write the identify the solutions on the board.
7/ Repeat the taste test.
8/ The teacher will tally the correct responses from each group for each solution, with and without the blindfold.
9/ Compare the tallies of correct responses.

C/Sugar 1%, A/ Sugar 0.1%
E/ Sugar 0.01%,F/ Salt 1%
G/ Salt 0.1%,B/ Salt 0.01%
D/ Water

Solution	Taste (no blindfold)	Tally	Taste (blindfold)	Tally
A				
B				
C				
D				
E				
F				
G				

Result: More correct responses were recorded for the weaker solutions when the subjects were blindfolded.

Conclusion: In some experiments the tester sometimes purposely or accidentally gives clues to the subject about the expected result. In a double blind trial neither the tester or the subject knows what to expect. Double blind trials are needed when testing medications or treatments. This experiment makes good use of replication.

Risk Level: Low Hazard: Beware of students clowning around when blind folded.

STUDENT:________________

216

Residual Error

Aim: To determine residual error as a measure of accuracy in an experiment to determine the acceleration due to gravity.

Equipment

Stop watch
Tennis ball

Procedure

1/ One student proceeds with the tennis ball to a first floor walkway and holds the ball level with the top of the railing.
2/ A second student remains below with the stop watch.
3/ The student with the ball gives a countdown," 3,2,1, go", releasing the ball on "go" .
4/ The student below times the fall of the ball to the ground.
5/ Repeat the procedure six times, recording each result in the table below.
6/ For each result calculate "g" , the acceleration due to gravity.
7/ Calculate the average value for "g"
8/ Find the "residual error", the difference between the average and the result most different from the average.
9/ Express the result as: average$\pm$ residual error m/sec/sec.

Trial	Fall time (t)	Height (h)	g (2h/tt)
1			
2			
3			
4			
5			
6			
		Average	

Results: ____

____

____

Conclusion: ____

____

____

____

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216

Residual Error

Topics: Scientific Method Gravity

Aim: To determine residual error as a measure of accuracy in an experiment to determine the acceleration due to gravity.

Equipment

Stop watch

Tennis ball

Procedure

1/ One student proceeds with the tennis ball to a first floor walkway and holds the ball level with the top of the railing.

2/ A second student remains below with the stop watch.

3/ The student with the ball gives a countdown," 3,2,1, go", releasing the ball on "go" .

4/ The student below times the fall of the ball to the ground.

5/ Repeat the procedure six times, recording each result in the table below.

6/ For each result calculate "g" , the acceleration due to gravity.

7/ Calculate the average value for "g"

8/ Find the "residual error", the difference between the average and the result most different from the average.

9/ Express the result as: average$\pm$ residual error m/sec/sec.

A tape measure is needed to determine the fall from the railing to the ground.

Trial	Fall time (t)	Height (h)	g (2h/tt)
1			
2			
3			
4			
5			
6			
		Average	

Result: The acceleration due to gravity should be 9.8

Conclusion: Residual error gives a measure of the accuracy of the results by showing how much the results may deviate from the average. The main source of error in this experiment is the reaction time of the stop watch operator. Best results are obtained by those operators who anticipate the release and the impact.

Risk Level: Low Hazard:

STUDENT:____________________

217 Statistical Analysis

Aim: To compare results in an experiment involving natural variation eg. Does corn grow faster with urea.

Equipment

Seedling Trays, two, (30cmX 30cmX 7cm)
40 corn seeds
Potting mix
Urea
Beaker, 800ml

Procedure

1/ Fill both seedling trays with moistened potting mix.
2/ Plant 20 seeds in each tray , 4 rows of 5 seeds 1cm deep.
3/ Label one tray "control" and one tray "urea".
4/ Pour 800ml of water evenly over the "control" tray
5/ Dissolve 2g of urea in 800ml of water and apply evenly to the " urea" tray.
6/ Place both trays in a warm sunny position. Cover the trays with fly screen for 4 days to prevent mice eating the seeds.
7/ Water the control tray and apply urea to the test tray every three or four days for two weeks.

SAMPLING- Measure the height of one plant in each tray. Is this a reliable comparison between the control and test group? If not, explain.

AVERAGING- Record the height of each plant in the table below then compare the average height of each group. Compare your "control" average with the "control" averages from other groups. Does this mean your control is better or worse than the controls in other groups?

Control Group Heights (cm)				Urea Group Heights (cm)			
Average (Sum/ number)=				Average (Sum/ number)=			

Results: ____

____

____

Conclusion: ____

____

____

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217

Statistical Analysis

Topics: Scientific Method Plants

Aim: To compare results in an experiment involving natural variation eg. Does corn grow faster with urea.

Equipment

Seedling Trays, two, (30cmX 30cmX 7cm)
40 corn seeds
Potting mix
Urea
Beaker, 800ml

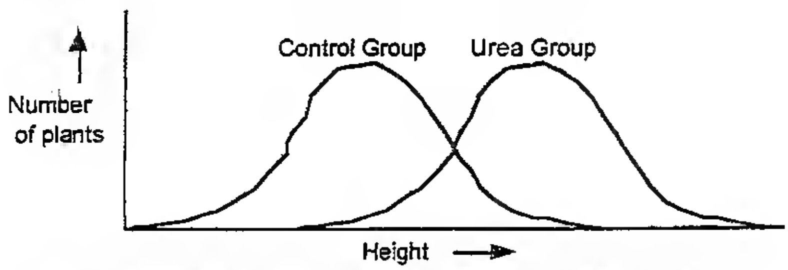
Teacher - do a Standard Error Analysis between two control groups and between a urea and control group.

Procedure

1/ Fill both seedling trays with moistened potting mix.
2/ Plant 20 seeds in each tray , 4 rows of 5 seeds 1cm deep.
3/ Label one tray "control" and one tray "urea".
4/ Pour 800ml of water evenly over the "control" tray
5/ Dissolve 2g of urea in 800ml of water and apply evenly to the " urea" tray.
6/ Place both trays in a warm sunny position. Cover the trays with fly screen for 4 days to prevent mice eating the seeds.
7/ Water the control tray and apply urea to the test tray every three or four days for two weeks.

SAMPLING- Measure the height of one plant in each tray. Is this a reliable comparison between the control and test group? If not, explain.

AVERAGING- Record the height of each plant in the table below then compare the average height of each group. Compare your "control" average with the "control" averages from other groups. Does this mean your control is better or worse than the controls in other groups?



Explain to the students that all the measurements for the control groups will fall under the "normal curve" above. While the average for each group will be different , they are not "significantly different". Standard Error Analysis will show the urea group is significantly higher.

Result: Two weeks after planting, the average height of the corn treated with 0.25% urea was higher than the average height of corn given identical watering, soil and sunlight.

Conclusion: Sampling is unreliable because plants vary in height in each group. Sampling needs to be repeated many times. Comparing average heights of the groups showed a difference but the averages of control group were also different due to natural variation in the plants. Standard Error Analysis showed control groups to be the same and urea groups significantly better.

Risk Level: Low Hazard: Urea can irritate the eyes and skin.

STUDENT:____________________

218

The Fizz

Aim: To use the reaction of acids and carbonates to make a sweet with a fizzing bite.

Equipment

Cream of Tartar
(ground Tartaric acid)
Baking Soda
(sodium bicarbonate)
Icing sugar
(ground sucrose)
Teaspoon (Food Tech)
Paper Bag,small (canteen)

Procedure

1/ Place one third of a teaspoon of creme of tartar in the paper bag.
2/ Add one third of a teaspoon of baking soda.
3/ Crush any lumps.
4/ Shake the paper bag to mix the acid and carbonate.
5/ Add two heaped teaspoons of icing sugar.
6/ Shake the paper bag for 30 seconds.
7/ Taste the product.

- Explain what happens in your mouth to create an unusual sensation.

Results: ____

____

____

Conclusion: ____

____

____

____

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218

The Fizz

Topics: Acids & Bases

Aim: To use the reaction of acids and carbonates to make a sweet with a fizzing bite.

Equipment

Cream of Tartar
(ground Tartaric acid)
Baking Soda
(sodium bicarbonate)
Icing sugar
(ground sucrose)
Teaspoon (Food Tech)
Paper Bag, small (canteen)

Procedure

1/ Place one third of a teaspoon of creme of tartar in the paper bag.
2/ Add one third of a teaspoon of baking soda.
3/ Crush any lumps.
4/ Shake the paper bag to mix the acid and carbonate.
5/ Add two heaped teaspoons of icing sugar.
6/ Shake the paper bag for 30 seconds.
7/ Taste the product.

- Explain what happens in your mouth to create an unusual sensation.

This practical is very popular with students and often related to parents.

Result: The mixture tastes sweet but also tingles in a biting fizz.

Conclusion: Acids and carbonates react to produce bubbles of carbon dioxide, a salt and water. Tartaric acid and baking soda cannot react until dissolved. When the mixture is placed in your mouth, saliva provides a liquid to dissolve the ingredients and allow the reaction to take place. Your tongue is assaulted by bubbles of carbon dioxide and brief tastes of bitter and sour.

Risk Level: Low Hazard: Students always think more is better. They are likely to double or triple the quantities unless you are vigilant. Students are also prone to eat more than is good for themselves. The sugar boost is also likely to make their behaviour a problem. This practical is best performed in the last 20 minutes before a break.

STUDENT:____________________

219

Amphoteric salts

Aim: To demonstrate that some salts have both acidic and basic properties.

Equipment

Test Tubes, 2
Test Tube Rack
Dropper Bottles of:
Hydrochloric Acid
Sodium Hydroxide (1%)
Suspensions of:
Zinc Hydroxide(1%)
Aluminium Hydroxide (1%)
Copper Hydroxide (1%)
Calcium Hydroxide (1%)

Procedure

1/ Add about 2cm of the copper hydroxide suspension to each of the test tubes.
2/ To one tube add drops of hydrochloric acid and record any change.
3/ To the second tube add drops of sodium hydroxide and record any change.
4/ Thoroughly rinse the tubes and repeat the experiment for zinc hydroxide.
5/ Repeat the steps for calcium hydroxide and then aluminium hydroxide.

Hydroxide	Reaction with Acid	Reaction with Base
Copper		
Zinc		
Calcium		
Aluminium		

Results: ____

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Conclusion: ____

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219

Amphoteric salts

Topics: Acids and Bases

Aim: To demonstrate that some salts have both acidic and basic properties.

Equipment

Test Tubes, 2
Test Tube Rack
Dropper Bottles of:
Hydrochloric Acid
Sodium Hydroxide (1%)
Suspensions of:
Zinc Hydroxide(1%)
Aluminium Hydroxide (1%)
Copper Hydroxide (1%)
Calcium Hydroxide (1%)

Procedure

1/ Add about 2cm of the copper hydroxide suspension to each of the test tubes.
2/ To one tube add drops of hydrochloric acid and record any change.
3/ To the second tube add drops of sodium hydroxide and record any change.
4/ Thoroughly rinse the tubes and repeat the experiment for zinc hydroxide.
5/ Repeat the steps for calcium hydroxide and then aluminium hydroxide.

If some hydroxides are unavailable, dilute NaOH is added drop wise to 1% nitrate solution until precipitation.

Hydroxide	Reaction with Acid	Reaction with Base
Copper		
Zinc		
Calcium		
Aluminium		

Result: Copper and calcium hydroxide react only with acid. Zinc and aluminium hydroxide react with both acid and with a base.

Conclusion: Zinc and aluminium hydroxide are amphoteric, that is, reacting as both acids and bases eg.

$Zn(OH)_2 + 2H^+ > Zn^{2+} + H_2O$, $Zn(OH)_2 + OH^- > Zn(OH)_3^-$

Risk Level: Mild Hazard: Zinc and copper salts are harmful if ingested. Calcium hydroxide is caustic and contact with the skin should be avoided. Sodium hydroxide is very caustic and any contact with the skin treated with prolonged rinsing with water. Hydrochloric acid is corrosive however at 1% concentration poses little hazard.

STUDENT:____________________

220

Metallic Order

Aim: To determine a rank order or chemical activity among a selection of metals.

Equipment

Nitric Acid, 0.1M (0.6%, in a dropper bottle)
Test tube rack
Test Tubes, medium, six
Copper strip
Iron pieces
Tin granules
Lead shot
Magnesium Ribbon
Zinc granules
Universal Indicator (in a dropper bottle)
Steel wool

Procedure

1/ Add 20 drops of nitric acid to each test tube.
2/ Add two drops of universal indicator to each test tube.
3/ Clean the copper samples with steel wool and rinse in water.
4/ Add a sample of copper to the first tube, iron to the second and so on until each tube contains a metal.
5/ After a while the solutions will begin to change colour from red to orange indicating reaction with the acid.
6/ Record the order in which the metals change the the indicator colour.

Reactivity order	Metal
1st	
2nd	
3rd	
4th	
5th	
6th	

Results: ____

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Conclusion: ____

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220

Metallic Order

Topics: Acids and Bases Elements

Aim: To determine a rank order or chemical activity among a selection of metals.

Equipment

Nitric Acid, 0.1M (0.6%, in a
dropper bottle)
Test tube rack
Test Tubes, medium, six
Copper strip
Iron pieces
Tin granules
Lead shot
Magnesium Ribbon
Zinc granules
Universal Indicator (in a dropper bottle)
Steel wool

Plan a second activity as this experiment may take an hour.

Procedure

1/ Add 20 drops nitric acid to each test tube.
2/ Add two drops of universal indicator to each test tube.
3/ Clean the copper samples with steel wool and rinse in water.
4/ Add a sample of copper to the first tube, iron to the second and so on until each tube contains a metal.
5/ After a while the solutions will begin to change colour from red to orange indicating reaction with the acid.
6/ Record the order in which the metals change the the indicator colour.

Reactivity order	Metal
1st	
2nd	
3rd	
4th	
5th	
6th	

Result: The order of colour change is Magnesium first; then zinc, iron, tin, copper and finally lead.

Conclusion: The order of reactivity of the metals (most reactive to least reactive) is Magnesium, zinc, iron, tin, copper and lead.
Surface area affects reaction rate but in this case the difference in reactivity should more than compensate.

Risk Level: Low Hazard: Nitric acid is corrosive but poses negligible hazard at 0.1M concentration.

STUDENT:____________________

221

Plant Indicators

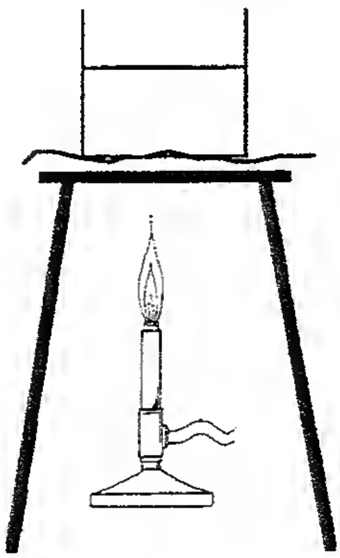
Aim: To make a dye solution which indicates the presence of acids or bases

Equipment

Red Cabbage (1/2 cup)
Beaker, 250ml
Wire gauze
Tripod
Bunsen
Test Tube Rack
Test tubes, medium, two
Hydrochloric acid, 0.1M(1%)
Sodium Hydroxide, 0.1M(4%)
Dropper bottle

Procedure

1/ Place the chopped plant material in the beaker.
2/ Half fill the beaker with water.
3/ Place the beaker on the wire gauze and tripod.
4/ Heat the beaker with a Bunsen until the water has boiled for five minutes.
5/ Pour some of the liquid into a dropper bottle.
6/ Add 2cm of acid to one test tube.
7/ Add a few dropps of your indicator liquid.
8/ Add 2cm of sodium hydroxide to the second test tube.
9/ Add a few drops of your indicator liquid.



Results: ____

Conclusion: ____

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221

Plant Indicators

Topics: Acids and Bases Plants

Aim: To make a dye solution which indicates the presence of acids or bases

Equipment

Red Cabbage (1/2 cup)
Beaker, 250ml
Wire gauze
Tripod
Bunsen
Test Tube Rack
Test tubes, medium, two
Hydrochloric acid, 0.1M(1%)
Sodium Hydroxide, 0.1M(4%)
Dropper bottle

Grated beetroot or red hibiscus flowers are acceptable alternatives to red cabbage.

Procedure

1/ Place the chopped plant material in the beaker.
2/ Half fill the beaker with water.
3/ Place the beaker on the wire gauze and tripod.
4/ Heat the beaker with a Bunsen until the water has boiled for five minutes.
5/ Pour some of the liquid into a dropper bottle.
6/ Add 2cm of acid to one test tube.
7/ Add a few drops of your indicator liquid.
8/ Add 2cm of sodium hydroxide to the second test tube.
9/ Add a few drops of your indicator liquid.

Result: The purple dye extracted from the cabbage turns red in acid and blue in a base.

Conclusion: The natural dye from cabbage will indicate the presence of acids or bases.

Risk Level: Low Hazard: At 0.1M concentrations, hydrochloric acid and sodium hydroxide pose very little hazard.

STUDENT: ____________________

Titration 1

Aim: To determine the concentration of an acid by reaction with a carbonate.

Equipment

Burette and burette clamp
Retort stand
Measuring cylinder, 100ml
Conical flask, 250ml
Methyl Red, 1% (in dropper bottle)
Sodium Hydrogen Carbonate,0.1M (8.4 g dissolved in 1 litre water in a volumetric flask.)
Hydrochloric Acid
Filter funnel, small

Procedure

1/ Carefully rinse the burette with the acid.
2/ Fill the burette with acid to the top then clamp the burette to the retort stand so there is about 15cm clearance to the bench.
3/ Place the conical flask beneath the burette and release the burette tap until the acid reaches the 0.0ml mark.
4/ Thoroughly rinse the conical flask and then add 50ml of the sodium hydrogen carbonate solution.
5/ Add four drops of Methyl Red solution to the flask.
6/ Place a sheet of white paper under the flask .
7/ Adust the burette tap to slowly add acid to the flask.
8/ Swirl the contents of the conical flask with your left hand while grasping the burette tap with your right hand.
9/ Spashes of red will appear in the flask as the acid enters but then dissapear as the solution is swirled.
10/ When the splashes of red begin to linger, slow the burette drop rate to about 1 every 2 seconds.
11/ When the red colour no longer clears, turn off the burette tap and record how much acid was used.

Results: ____

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Conclusion: ____

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222

Titration 1

Topics: Acids and Bases

Aim: To determine the concentration of an acid by reaction with a carbonate.

Equipment

Burette and burette clamp
Retort stand
Measuring cylinder, 100ml
Conical flask, 250ml
Methyl Red, 1% (in dropper bottle)
Sodium Hydrogen Carbonate,0.1M (8.4 g dissolved in 1 litre water in a volumetric flask.)
Hydrochloric Acid
Filter funnel, small

Hydrochloric acid 0.2M, 2%

Procedure

1/ Carefully rinse the burette with the acid.
2/ Fill the burette with acid to the top then clamp the burette to the retort stand so there is about 15cm clearance to the bench.
3/ Place the conical flask beneath the burette and release the burette tap until the acid reaches the 0.0ml mark.
4/ Thoroughly rinse the conical flask and then add 50ml of the sodium hydrogen carbonate solution.
5/ Add four drops of Methyl Red solution to the flask.
6/ Place a sheet of white paper under the flask .
7/ Adjust the burette tap to slowly add acid to the flask.
8/ Swirl the contents of the conical flask with your left hand while grasping the burette tap with your right hand.
9/ Splashes of red will appear in the flask as the acid enters but then disappear as the solution is swirled.
10/ When the splashes of red begin to linger, slow the burette drop rate to about 1 every 2 seconds.
11/ When the red colour no longer clears, turn off the burette tap and record how much acid was used.

Result: 25ml of acid was needed to neutralise 50ml of the sodium hydrogen carbonate.

Conclusion: The acid is twice as concentrated as the 1M sodium hydrogen carbonate solution.

Risk Level: Moderate Hazard: Hydrochloric acid is corrosive and any contact with the skin should be vigorously washed in water. While the chemicals pose only a moderate hazard, junior students are likely to break expensive burettes.

STUDENT:____________________

223

Titration 2

Aim: To determine the molarity of a base solution

Equipment

Burette and burette clamp
Retort stand
Measuring cylinder, 100ml
Conical flask, 250ml
Methyl Red, 1% (in dropper bottle)
Hydrochloric Acid, 0.20M
Filter funnel, small
Sodium Hydroxide solution

Procedure

1/ Carefully rinse the burette with the acid.
2/ Fill the burette with acid to the top then clamp the burette to the retort stand so there is about 15cm clearance to the bench.
3/ Place the conical flask beneath the burette and release the burette tap until the acid reaches the 0.0ml mark.
4/ Thoroughly rinse the conical flask and then add 30ml of the sodium hydroxide solution.
5/ Add four drops of Methyl Red solution to the flask.
6/ Place a sheet of white paper under the flask .
7/ Adust the burette tap to slowly add acid to the flask.
8/ Swirl the contents of the conical flask with your left hand while grasping the burette tap with your right hand.
9/ Spashes of red will appear in the flask as the acid enters but then disappear as the solution is swirled.
10/ When the splashes of red begin to linger, slow the burette drop rate to about 1 every 2 seconds.
11/ When the red colour no longer clears, turn off the burette tap and record how much acid was used.

HCL + NaOH > NaCl + H_2O

Moles of Acid used = Moles of Base nuetralised

Moles of acid used = Molarity X volume

= 0.20 X _____(litres)

= ________

Molarity of Base = Moles / volume

= ______ / ______

= ______M

Results: ____

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Conclusion: ______________________________________

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223

Titration 2

Topics: Acids and Bases Molarity

Aim: To determine the molarity of a base solution

Equipment

Burette and burette clamp
Retort stand
Measuring cylinder, 100ml
Conical flask, 250ml
Methyl Red, 1% (in dropper bottle)
Hydrochloric Acid, 0.20M
Filter funnel, small
Sodium Hydroxide solution

Sodium Hydroxide,0.15M, 6%
Use the standardised acid from Titration 1 adjusted to 0.20M.

Procedure

1/ Carefully rinse the burette with the acid.
2/ Fill the burette with acid to the top then clamp the burette to the retort stand so there is about 15cm clearance to the bench.
3/ Place the conical flask beneath the burette and release the burette tap until the acid reaches the 0.0ml mark.
4/ Thoroughly rinse the conical flask and then add 30ml of the sodium hydroxide solution.
5/ Add four drops of Methyl Red solution to the flask.
6/ Place a sheet of white paper under the flask .
7/ Adjust the burette tap to slowly add acid to the flask.
8/ Swirl the contents of the conical flask with your left hand while grasping the burette tap with your right hand.
9/ Splashes of red will appear in the flask as the acid enters but then disappear as the solution is swirled.
10/ When the splashes of red begin to linger, slow the burette drop rate to about 1 every 2 seconds.
11/ When the red colour no longer clears, turn off the burette tap and record how much acid was used.

$HCL + NaOH > NaCl + H_2O$

Moles of Acid used = Moles of Base nuetralised
Moles of acid used = Molarity X volume
= 0.20 X 0.0225(litres)
= 0.0045
Molarity of Base = Moles / volume
= 0.045 / 0.030
= 1.50 M

Result: 22.5mls of acid was required to neutralise 30mls of sodium hydroxide solution.

Conclusion: The concentration of the sodium hydroxide solution is 0.15M.

Risk Level: Moderate Hazard: Sodium hydroxide is caustic and hydrochloric acid is corrosive. If either of these reagents should contact skin the area should be treated with prolonged washing with water. While the chemicals are only moderately hazardous, junior students are very likely to break expensive burettes.

STUDENT:________________

224

Tin Canometer

Aim: To measure the height of clouds with a tin can and a thermometer.

Equipment

Tin can
Thermometer, 0-100

Procedure

Dew Point is the temperature at which dew begins to form.

1/ Fill a tin can with tepid water.
2/ Place a thermometer in the can and hold it agianst the metal side.
3/ Add a half a cup of crushed ice to the can.
4/ Record the temperature at which moisture just begins to form on the outside of the can.
5/ Remove and dry the thermometer then hold it in the air, out of the sun. Record the temperature after 3 minutes.

Air temperature decreases with height from the ground, about one degree for every 120 metres. When the Dew Point temperature is reached, water vapour in the air begins to condense to form cloud. The height of cumulus clouds on a particular day can be calculated as follows:

$H = (T - DP) X 120$, H= height in metres
T = air temperature
DP= Dew Point temperature

Results: ____

____

____

Conclusion: ____

____

____

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224

Tin Canometer

Topics: Atmosphere Matter

Aim: To measure the height of clouds with a tin can and a thermometer.

Equipment

Tin can

Thermometer, 0-100

Procedure

Dew Point is the temperature at which dew begins to form.

1/ Fill a tin can with tepid water.

2/ Place a thermometer in the can and hold it against the metal side.

3/ Add a half a cup of crushed ice to the can.

4/ Record the temperature at which moisture just begins to form on the outside of the can.

5/ Remove and dry the thermometer then hold it in the air, out of the sun. Record the temperature after 3 minutes.

Air temperature decreases with height from the ground, about one degree for every 120 metres. When the Dew Point temperature is reached, water vapour in the air begins to condense to form cloud. The height of cumulus clouds on a particular day can be calculated as follows:

$H = (T - DP) \times 120$, H= height in metres

T = air temperature

DP= Dew Point temperature

Result: Typically Cumulus cloud forms at around 1000 metres above the ground.

Conclusion: The height is in metres above your position. The Dew Point temperature will vary depending on the humidity in the air and air temperature.

Risk Level: Low Hazard:

STUDENT:________________

225 Conservation of Mass

Aim: To demonstrate that the total mass of the products of a reaction must equal the total mass of the reactants.

Equipment

Glass Jar (wide mouth and screw cap lid)
Specimen Tube (to fit inside the glass jar)
Balance, 0.01g
Forceps
Hydrochloric Acid 1M(10%)
Copper Carbonate

Procedure

1/ Accurately weight the glass jar (with lid).
2/ Weigh 0.5g of copper carbonate into the jar.
3/ Accurately weigh the specimen tube.
4/ Weigh 5.0g of hydrochloric acid (1M) into the specimen tube.
5/ Using forceps, carefully lower the specimen tube into the jar.
6/ Seal the jar
7/ Briefly up end the jar to mix the reactants.
8/ Reweigh the Jar.
9/ Release the lid of the jar, allowing the gasses to escape.
10/ Reseal and reweigh the jar.

- Write a balanced equation for the reaction.
- Name the gas and the salt produced.
- Why is it not possible to calculate the weight of salt produced?

Object	Weight	Calculated Weight
Glass Jar with lid		X
Copper Carbonate added		X
Specimen Tube		X
Hydrochloric Acid added		X
Weight of Reactants	X	
Total Weight after Reaction		X
Weight of Products	X	
Weight after Gas released		X
Weight of gas produced	X	

Results: ____

____

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Conclusion: ____

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225

Conservation of Mass

Topics: Chem Rns

Aim: To demonstrate that the total mass of the products of a reaction must equal the total mass of the reactants.

Equipment

Glass Jar (wide mouth and screw cap lid)
Specimen Tube (to fit inside the glass jar)
Balance, 0.01g
Forceps
Hydrochloric Acid 1M(10%)
Copper Carbonate

Procedure

1/ Accurately weight the glass jar (with lid).
2/ Weigh 0.5g of copper carbonate into the jar.
3/ Accurately weigh the specimen tube.
4/ Weigh 5.0g of hydrochloric acid (1M) into the specimen tube.
5/ Using forceps, carefully lower the specimen tube into the jar.
6/ Seal the jar
7/ Briefly up end the jar to mix the reactants.
8/ Reweigh the Jar.
9/ Release the lid of the jar, allowing the gasses to escape.
10/ Reseal and reweigh the jar.

- Write a balanced equation for the reaction.
- Name gas and the salt produced.
- Why is it not possible to calculate the weight of salt produced?

Object	Weight	Calculated Weight
Glass Jar with lid		X
Copper Carbonate added		X
Specimen Tube		X
Hydrochloric Acid added		X
Weight of Reactants	X	
Total Weight after Reaction		X
Weight of Products	X	
Weight after Gas released		X
Weight of gas produced	X	

Result: The copper carbonate reacts with the acid producing bubbles of gas and a dark green solution.

Conclusion: The mass of the reactants equalled the mass of the products.
$CuCO_3 + 2HCl > CuCl_2 + H_2O + CO_2$. The gas produced is carbon dioxide.
The salt produced is copper chloride. Since water is also produced in the reaction only the weight of the salt plus the water can be deduced.

Risk Level: Moderate Hazard: Hydrochloric acid is corrosive and contact with the skin should be treated with prolonged washing. Copper salts are harmful by ingestion and skin contact should be avoided.

STUDENT:____________________

226

Reaction Rate

Aim: To examine the factors affecting reaction rate.

Equipment

Test Tube ,20ml, 5
Test Tube Rack
Test Tube clamp
Thermometer, 0 - 100C
Stick of chalk
Hydrochloric Acid 1M(10%)
Measuring Cylinder, 10ml
Filter paper
Hot water or boiling beaker at teacher bench.

Procedure

1/ Place four test tubes in the rack.
3/ Break off a 1cm piece of chalk and add it to tube 1.
4/ Use a ruler to crush the remaining chalk on a piece paper and divide the powder into three equal piles.
5/ Scrape one pile onto a filter paper and pour the powder into test tube 2. Repeat to add powder to tubes 3 and 4.
6/ Measure 5mls of water into tube 2.
7/ Measure 5mls of 1M Hydrochloric acid into test tube 1 and record your observations in the table below.
8/ Measure 5mls of acid into test tube 2. Record whether the reaction is faster or slower than tube 1.
9/ Measure 5mls of acid into test tube 3. Record whether the reaction is faster or slower than tube 2.
10/ Add 5mls of acid to a clean test tube. Add a thermometer to the tube and heat to 50 C by placing in hot water.
11/ Add the heated acid to tube 4. Record whether the reaction is faster or slower than tube 2.

Trial	Observations
1. Chalk piece, acid	
2. Chalk powder,diluted acid	
3. Chalk powder, acid	
4. Chalk powder, hot acid	

Results: ____

____

____

Conclusion: ____

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226

Reaction Rate

Topics: Chemical Rns Equilibrium

Aim: To examine the factors affecting reaction rate.

Equipment

Test Tube ,20ml, 5
Test Tube Rack
Test Tube clamp
Thermometer, 0 - 100C
Stick of chalk
Hydrochloric Acid 1M(10%)
Measuring Cylinder, 10ml
Filter paper
Hot water or boiling beaker at teacher bench.

Procedure

1/ Place four test tubes in the rack.
3/ Break off a 1cm piece of chalk and add it to tube 1.
4/ Use a ruler to crush the remaining chalk on a piece paper and divide the powder into three equal piles.
5/ Scrape one pile onto a filter paper and pour the powder into test tube 2. Repeat to add powder to tubes 3 and 4.
6/ Measure 5mls of water into tube 2.
7/ Measure 5mls of 1M Hydrochloric acid into test tube 1 and record your observations in the table below.
8/ Measure 5mls of acid into test tube 2. Record whether the reaction is faster or slower than tube 1.
9/ Measure 5mls of acid into test tube 3. Record whether the reaction is faster or slower than tube 2.
10/ Add 5mls of acid to a clean test tube. Add a thermometer to the tube and heat to 50 C by placing in hot water.
11/ Add the heated acid to tube 4. Record whether the reaction is faster or slower than tube 2.

Trial	Observations
1. Chalk piece, acid	
2. Chalk powder,diluted acid	
3. Chalk powder, acid	
4. Chalk powder, hot acid	

Result: Chalk reacts with acid to produce bubbles and heat. The reaction was slowest in tube 1, faster in tube 2, faster again in tube 3 and very fast in tube 4.

Conclusion: The rate of a reaction is increased by : increasing the surface area for reaction (crushing the chalk) , increasing the concentration of acid and by increasing the temperature.

Risk Level: Moderate Hazard: 1M Hydrochloric acid is mildly corrosive. Skin contact should be avoided and treated with thorough washing. Heating the acid is an additional hazard.

STUDENT:____________________

227

Ignition

Aim: To safely ignite a reactive mixture.

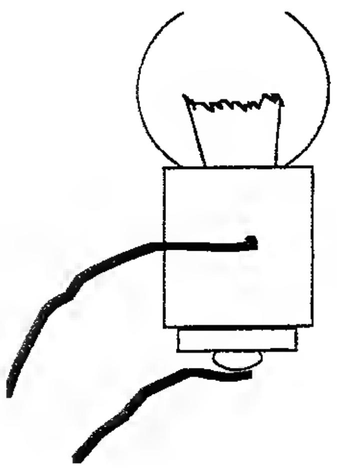
Equipment

Torch globe, 3V
Triangular file, small
Insulated wire, 30cm, two
Soldering Iron, electric
Heat Mat
Electrical solder
Chemical powder
5m of twin lead wires
Power supply, 12V DC
Wire stripping tool

Procedure

1/ File the tip of the globe until a hole is made in the glass.
2/ Place the globe and soldering iron on the heat tile.
3/ Turn on the soldering iron and wait 3 minutes for heating.
4/ Strip both ends of the two insulated wires.
5/ Rest the end of one wire on the metal sleeve of the globe.
6/ Press the soldering iron to the wire end and count to five.
7/ Touch some electrical solder to the soldering iron tip until a drop of solder melts onto the wire and globe.
8/ Place the end of the second wire against the round metal base of the globe.
9/ Repeat steps 6 and 7.
IN THE FUME HOOD AND UNDER SUPERVISION
10/ Gently add a little chemical powder into the globe.
11/ Place a teaspoon of chemical mix on a heat tile and nestle the globe into the mix.
12/ Connect the globe wires to the long lead wires.
13/ At a bench away from the fume hood, connect the lead wires to the power supply DC terminals.
14/ Set the supply to 12V and turn on the power.

Torch Globe Ignition Fuse



Under no circumstances should the fuse wires be connected to the lead wires unless the lead wires are diconnected from the power supply

Results: ____________________

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Conclusion: ____________________

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227

Ignition

Topics: Chemical Runs

Aim: To safely ignite a reactive mixture.

Equipment

Torch globe, 3V
Triangular file, small
Insulated wire, 30cm, two
Soldering Iron, electric
Heat Mat
Electrical solder
Chemical powder
5m of twin lead wires
Power supply, 12V DC
Wire stripping tool

Chemical Powder: finely ground sodium nitrate mixed with an equal volume of pure icing sugar.

Procedure

1/ File the tip of the globe until a hole is made in the glass.
2/ Place the globe and soldering iron on the heat tile.
3/ Turn on the soldering iron and wait 3 minutes for heating.
4/ Strip both ends of the two insulated wires.
5/ Rest the end of one wire on the metal sleeve of the globe.
6/ Press the soldering iron to the wire end and count to five.
7/ Touch some electrical solder to the soldering iron tip until a drop of solder melts onto the wire and globe.
8/ Place the end of the second wire against the round metal base of the globe.
9/ Repeat steps 6 and 7.
IN THE FUME HOOD AND UNDER SUPERVISION
10/ Gently add a little chemical powder into the globe.
11/ Place a teaspoon of chemical mix on a heat tile and nestle the globe into the mix.
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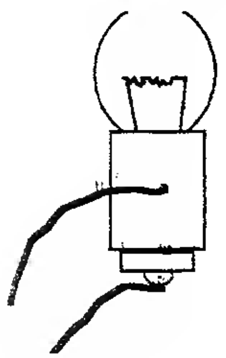
13/ At a bench away from the fume hood, connect the lead wires to the power supply DC terminals.
14/ Set the supply to 12V and turn on the power.

Torch Globe Ignition Fuse



Under no circumstances should the fuse wires be connected to the lead wires unless the lead wires are diconnected from the power supply

Result: The torch globe fuse instantly ignites the chemical powder.

Conclusion: Advantages: Nitrate or fuel soaked wicks can fail half way or have delays inviting close approach. Electrical fuses from hobby shops have a chemical coating which can cause fires. The globe size prevents effective confinement which can transform a fast burn into an explosion. Up to 100m of lead wire can be used with a 12V battery.

Risk Level: Moderate Hazard: Most boys will at some stage experiment with explosive mixtures. Accidents from these adventures are most often a result of attempts at ignition with matches or wicks. Showing the students how to create simple, cheap and safe electrical fuses may help avoid some of the accidents which occur every year. CLOSELY SUPERVISE THE CHEMICAL MIX AND THE IGNITION TESTS.

STUDENT:________________

228 Quantitative Assay

Aim: To determine the phosphate concentration in a water sample using colourmetric assay.

Equipment

Molybdate Reagent: Add 33ml of sulfuric acid to 500ml of water. Add water to 1 litre final volume. Add 2g ammonium molybdate.
Test tubes, medium,
Test tube racks,two
Laundry powder
Potassium Dihydrogen Phosphate, 0.00001M (0.136g in 1litre water)
Measuring cylinder,100ml
Colourimeter (optional)
Pipette, 10ml
Pipette, 1ml, two
Beaker, 250ml, two
Sulfuric acid, 0.1M, 5%

Procedure

1/ Rinse all glassware in 0.1M sufuric acid then in water.
2/ Add 1g of the laundry powder to 100ml of water in a beaker and dissolve.
3/ Dilution 1: Pipette 0.5ml of the solution into a test tube then add 4.5ml of water.
4/ Dilution 2: Pipette 0.5ml of Dilution 1 into a test tube and then add 4.5ml of water.
5/ Add 1ml of the potassium dihydrogen phoshate standard to a beaker and add 99ml of water.(1/100 standard)
6/ Dilute 1ml of this solution with 4mls of water ina test tube.
7/ Dilute 1ml of this solution with 4mls of water ina test tube.
8/ In a separate test ube rack add the following to separate test tubes: 0.5ml of laundry powder solution, 0.5ml of Dilution 1, 0.5ml of Dilution 2, 0.5ml of diluted standard 1/100, 0.5ml of diluted standard 1/500, 0.5ml of diluted standard 1/2500 and finally 0.5ml of water.
9/ Add 4.5ml of molybdate solution to the tubes in step 8.
10/ After 15minutes the tubes may be compared or read in a colorimeter.

Results: ________________________________

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Conclusion: ________________________________

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TEACHER COPY

228

Quantitative Assay

Topics: Chemical Runs Water

Aim: To determine the phosphate concentration in a water sample using colourmetric assay.

Equipment

Molybdate Reagent: Add 33ml of sulfuric acid to 500ml of water. Add water to 1 litre final volume. Add 2g ammonium molybdate.
Test tubes, medium,
Test tube racks,two
Laundry powder
Potassium Dihydrogen Phosphate, 0.00001M (0.136g in 1litre water)
Measuring cylinder,100ml
Colourimeter (optional)
Pipette, 10ml
Pipette, 1ml, two
Beaker, 250ml, two
Sulfuric acid, 0.1M, 5%

Procedure

1/ Rinse all glassware in 0.1M sulfuric acid then in water.
2/ Add 1g of the laundry powder to 100ml of water in a beaker and dissolve.
3/ Dilution 1: Pipette 0.5ml of the solution into a test tube then add 4.5ml of water.
4/ Dilution 2: Pipette 0.5ml of Dilution 1 into a test tube and then add 4.5ml of water.
5/ Add 1ml of the potassium dihydrogen phosphate standard to a beaker and add 99ml of water.(1/100 standard)
6/ Dilute 1ml of this solution with 4mls of water in a test tube.
7/ Dilute 1ml of this solution with 4mls of water in a test tube.
8/ In a separate test tube rack add the following to separate test tubes: 0.5ml of laundry powder solution, 0.5ml of Dilution 1, 0.5ml of Dilution 2, 0.5ml of diluted standard 1/100, 0.5ml of diluted standard 1/500, 0.5ml of diluted standard 1/2500 and finally 0.5ml of water.
9/ Add 4.5ml of molybdate solution to the tubes in step 8.
10/ After 15minutes the tubes may be compared or read in a colorimeter.

Many detergents contain phosphates from their method of manufacture. These phosphates are washed down sinks and drains to eventually enter creeks and rivers. Phoshate powerfully stimulates plant growth and in particular the growth of algae. Blooms of poisonous blue/green algae are increasingly affecting waterways during the warm summer months.

Result: The test tubes develop a blue colour, the intensity of which is dependent on the concentration of phosphate in the samples.

Conclusion: It is possible to to assess the phosphate contained in the laundry powder by comparing the colour developed in the diluted samples with the colour in the range of standard phosphate dilutions. If a colorimeter was used, absorbance can be graphed against standard concentration allowing a more accurate figure for the samples to be read from the graph.

Risk Level: Low Hazard: The acids, molybdate and phosphate pose no hazard at these concentrations (the reagents having been prepared by a laboratory assistant). The experiment itself requires good pipette technique and high levels of concentration from the students. The value of this experiment lies in its ability to accurately determine very low concentrations of a contaminant.

STUDENT:____________________

229

Smoke Bomb

Aim: To make a chemical reaction which produces a lot of smoke.

Equipment

Cotton rags
Sodium Nitrate
Tin can, 300ml approx
Beaker, 250ml
Retort stand
Boss head and clamp
Screw driver and hammer
Heat mat

Procedure

NOT TO BE CARRIED OUT BY STUDENTS

Results: ____________________

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Conclusion: ____________________

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229

Smoke Bomb

Topics: Chemical Rns

Aim: To make a chemical reaction which produces a lot of smoke.

Equipment

Cotton rags
Sodium Nitrate
Tin can, 300ml approx
Beaker, 250ml
Retort stand
Boss head and clamp
Screw driver and hammer
Heat mat

Procedure

1/ Add 100ml of water to the beaker.
2/ Dissolve 30g of sodium nitrate in the water.
3/ Tear the cotton cloth into long strips about 2cm wide
4/ Dip the cotton strips into the solution, squeeze dry and hang on a retort stand in the fume hood.
5/ Allow the strips to dry for two days.
6/ Punch breather holes in the sides of the can with the screw driver.
7/ Stuff the cloth strips into the can leaving 3cm of the last strip protruding.
8/ Take the can to a large open area eg. the oval.
9/ Stand the can on a heat mat.
10/ Ensure the prevailing breeze will not take the smoke into the school or nearby houses.
11/ Light the protruding cloth wick with a match and stand back.

Result: Copious volumes of smoke issue from the can for about a minute.

Conclusion: Sodium nitrate chemically oxidises cellulose in cotton however the oxidation is incomplete. Complete combustion of an organic substance produces invisible gases such as carbon dioxide and water vapour. Incomplete combustion produces small particles and droplets of organic compounds which refract and reflect light causing an opaque haze in the air.

Risk Level: EXTREMELY HAZARDOUS: Teacher demonstration only. The Principal and other staff should be warned. The smoke contains toxic organic compounds and should not be inhaled. Sodium nitrate is a powerful oxidising agent and can be explosive in mixtures containing reducing agents such as cyanides, aluminium powder or sodium thiosulfate. Sodium nitrate is harmful if ingested in quantity.

STUDENT:____________________

230 Consumer Science

Aim: To make use of the technical information provided on product labels.

Equipment

Various empty product containers eg.
Caustic Soda
Window Cleaner
Oven Cleaner
Baking powder
Soldering Flux
Hair Shampoo
Methylated Spirits
Bleach
Floor cleaner
Laundry detergent
Mayonnaise
Lemonade

Procedure

Examine the label of a product. In the space below record the name of the product, whether it carries a warning, the active ingredient or the main ingredient, and one additive if any. Repeat this procedure for another four products.

1/____

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2/____

____

3/____

____

4/____

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Results: ____

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Conclusion: ____

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230

Consumer Science

Topics: Consumer Science

Aim: To make use of the technical information provided on product labels.

Equipment

Various empty product containers eg.
Caustic Soda
Window Cleaner
Oven Cleaner
Baking powder
Soldering Flux
Hair Shampoo
Methylated Spirits
Bleach
Floor cleaner
Laundry detergent
Mayonnaise
Lemonade

Procedure

1/Give the students notes on or have them research the following terms:
Caustic, Corrosive, Toxic, Inflammable, Volatile, Wetting agent, Brightening Agent, Antioxidant, Softening Agent, Preservative, Emulsifier, Active Ingredient.
2/ Explain the labelling laws. Ingredients being listed in order of concentration. Distribute a copy of the additive number codes.

Result: Product labels contain much useful information besides its name and usage directions. Some carry directions in case of poisoning.

Conclusion: Warnings on products must be read for their safe use. The active ingredient quantity can be used to compare brands before you buy. Some products contain similar ingredients eg bleach and window cleaner, caustic soda and oven cleaner, yet the prices vary enormously. Some products contain additives which harm people with allergies.

Risk Level: Low Hazard

STUDENT:____________________

231 # Cosmetics 1

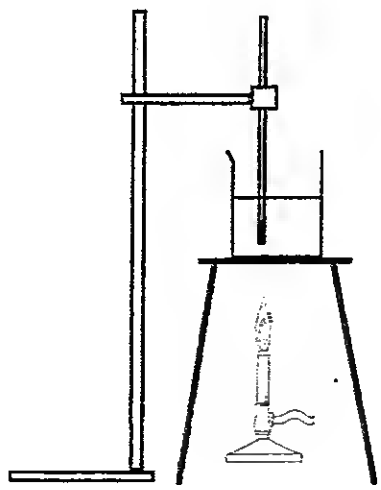
Aim: To make a simple cold cream.

Equipment

Candle wax
Liquid Paraffin
Borax
Thermometer, 0-100
Beakers, two, 250ml
Bunsen
Glass stirring rod
Tripod and gauze square
Flower essence
Retort stand
Boss head and clamp
Measuring Cylinder,100ml
Balance and filter paper

Procedure

1/ Measure 16g of candle wax and 50ml of liquid paraffin into a beaker.
2/ Support the beaker on a tripod and gauze square.
3/ Arrange the retort stand, boss head and clamp to support a thermometer in the paraffin.
4/ Use a Bunsen to carefully heat the wax and paraffin to 75 degrees Celsius. **Paraffin and candle wax are flammable.**
5/ Add 33mls of water and 1g of borax to a second beaker. Heat this mixture to 75 degrees, stirring until the borax is dissolved.
6/ Pour the borax solution into paraffin/wax mixture.
7/ Stir the combined mixtures continuously as they cool until a cream forms.
8/ Add two drops of flower essence and stir for another few minutes.
9/ Transfer the cream to a small jar.
10/ Clean the beakers, stirring rod and thermometer in hot water and detergent.



Results: ____

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Conclusion: ____

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231

Cosmetics 1

Topics: Consumer Science Organic Chem

Aim: To make a simple cold cream.

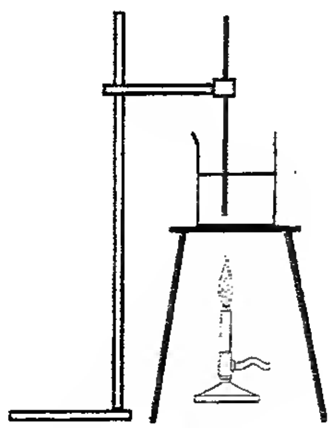
Equipment

Candle wax
Liquid Paraffin
Borax
Thermometer, 0-100
Beakers, two, 250ml
Bunsen
Glass stirring rod
Tripod and gauze square
Flower essence
Retort stand
Boss head and clamp
Measuring Cylinder,100ml
Balance and filter paper

Students should bring their own clean jar to receive the cold cream.

Procedure

1/ Measure 16g of candle wax and 50ml of liquid paraffin into a beaker.
2/ Support the beaker on a tripod and gauze square.
3/ Arrange the retort stand, boss head and clamp to support a thermometer in the paraffin.
4/ Use a Bunsen to carefully heat the wax and paraffin to 75 degrees Celsius. **Paraffin and candle wax are flammable.**
5/ Add 33mls of water and 1g of borax to a second beaker. Heat this mixture to 75 degrees, stirring until the borax is dissolved.
6/ Pour the borax solution into paraffin/wax mixture.
7/ Stir the combined mixtures continuously as they cool until a cream forms.
8/ Add two drops of flower essence and stir for another few minutes.
9/ Transfer the cream to a small jar.
10/ Clean the beakers, stirring rod and thermometer in hot water and detergent.



Result: A soft, scented, white cream is produced.

Conclusion: Cold cream is an emulsion of water, candle wax and paraffin oil which do not normally form a stable mixture.

Risk Level: Moderate Hazard: Candle wax and paraffin are both flammable.

STUDENT:____________________

232

Cosmetics 2

Aim: To produce a type of mascara.

Equipment

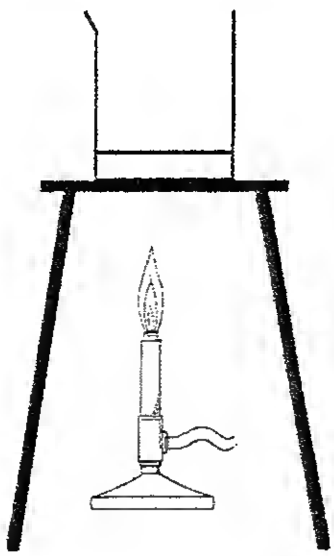
Candle wax
Beeswax
Triethanolamine
Lanolin
Charcoal Powder
Tripod and gauze square
Bunsen
Glass stirring rod
Beaker, 100ml
Watch glass
Balance and filter paper

Procedure

1/ Add the following to a beaker:

Candle wax	4g
Beeswax	1.2g
Charcoal Powder	1g

2/ Weigh 0.8g of lanolin onto a tared watch glass. Add 3g of Triethanolamine then pour both into the beaker.
3/ Gently heat the beaker on a tripod until the components just melt.
4/ Stir slowly with a glass rod as the mixture cools until a thick cream forms.
5/ Transfer the mixture to a small jar.
6/ Clean the beaker, watch glass and stirring rod with hot water and detergent.



Results: ____

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Conclusion: ____

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232

Cosmetics 2

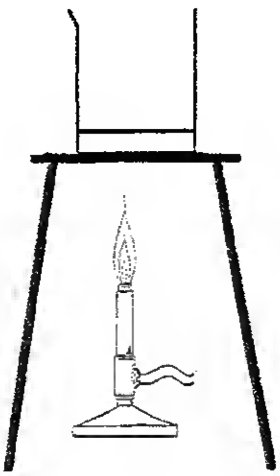
Topics: Consumer Science Organic Chem

Aim: To produce a type of mascara.

Equipment
Candle wax
Beeswax
Triethanolamine
Lanolin
Charcoal Powder
Tripod and gauze square
Bunsen
Glass stirring rod
Beaker, 100ml
Watch glass
Balance and filter paper

Procedure
1/ Add the following to a beaker:
Candle wax 4g
Beeswax 1.2g
Charcoal Powder 1g
2/ Weigh 0.8g of lanolin onto a tared watch glass. Add 3g of Triethanolamine then pour both into the beaker.
3/ Gently heat the beaker on a tripod until the components just melt.
4/ Stir slowly with a glass rod as the mixture cools until a thick cream forms.
5/ Transfer the mixture to a small jar.
6/ Clean the beaker , watch glass and stirring rod with hot water and detergent.

Students should bring their own small jar to receive the mascara.



Result: A thick, dark cream is formed.

Conclusion: Mascara is a suspension of dark charcoal powder in a semi-liquid mixture non-polar substances. Non-polar liquids do not mix with water and so not easily washed away.

Risk Level: Mild Hazard: Charcoal powder is not hazardous but is often messy. Students should be cautioned when heating small quantities.

STUDENT:________________

233

Cosmetics 3

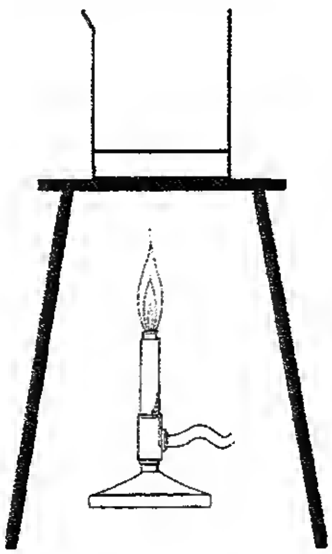
Aim: To produce a simple form of eye shadow or sun screen.

Equipment

Liquid Paraffin
Beeswax
Stearyl Alcohol
Zinc Oxide
Beaker, 100ml
Tripod and gauze square
Bunsen
Glass Stirring rod
Measuring Cylinder, 10ml

Procedure

1/ Measure 5ml of liquid paraffin and 2ml of stearyl alcohol into the beaker.
2/ Add 1.5g of beeswax.
3/ Heat the beaker gently until the wax melts.
4/ Stir a spatula of zinc oxide into the mixture.
5/ Transfer the mixture into a small container.
6/ Clean the beaker, stirring rod and measuring cylinder in hot water and detergent.



Results: ____

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Conclusion: ____

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233

Cosmetics 3

Topics: Consumer Science Organic Chem

Aim: To produce a simple form of eye shadow or sun screen.

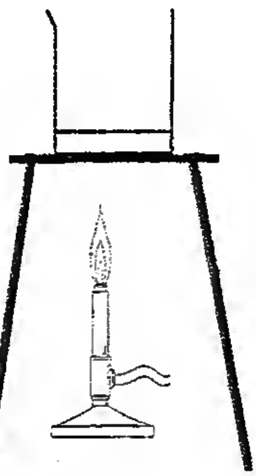
Equipment

Liquid Paraffin
Beeswax
Stearyl Alcohol
Zinc Oxide
Beaker, 100ml
Tripod and gauze square
Bunsen
Glass Stirring rod
Measuring Cylinder, 10ml

Procedure

1/ Measure 5ml of liquid paraffin and 2ml of stearyl alcohol into the beaker.
2/ Add 1.5g of beeswax.
3/ Heat the beaker gently until the wax melts.
4/ Stir a spatula of zinc oxide into the mixture.
5/ Transfer the mixture into a small container.
6/ Clean the beaker, stirring rod and measuring cylinder in hot water and detergent.

Students should bring their own small jar to receive the cream.



Result: A thick ,white cream is produced.

Conclusion: Sun screen and eye shadow are similar products, both being a suspension in a semi-liquid mixture of non-polar compounds. Non polar liquids do not mix with water and so are not easily washed away. Zinc Oxide absorbs ultra violet light protecting skin covered by the cream. Body sunscreen uses titanium oxide in a lanolin base.

Risk Level: Moderate Hazard: Liquid paraffin and beeswax are both flammable. Students should be cautioned when heating small quantities.

STUDENT:____________________

234 Laundry Detergents

Aim: To determine which of three common laundry detergents is best at removing stains in cold water.

Equipment

Laundry Detergents (3)
250ml beakers (4)
Plain cloth 30cm X 30cm
Stop watch
Thermometer
Stirring rod
Stains: tomato sauce
beetroot juice
muddy water
sump oil
black marker pen

Procedure

Devise a procedure to fairly compare the detergents.

Results: ____

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Conclusion: ____

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234

Laundry Detergents

Topics: Consumer Science Scientific Method

Aim: To determine which of three common laundry detergents is best at removing stains in cold water.

Equipment

Laundry Detergents (3)
250ml beakers (4)
Plain cloth 30cm X 30cm
Stop watch
Thermometer
Stirring rod
Stains: tomato sauce
beetroot juice
muddy water
sump oil
black marker pen

Procedure

Suggested procedure:
1/ Tear the cloth into four strips
2/ Mark each cloth strip with **equal** amounts of each stain.
3/ Place five grams of each detergent into a separate beaker
4/ Add 200mls of water to clean beaker. Measure and record the temperature of the water
5/ Add 200mls of water to the beakers with detergent.
6/ Stir for 10 seconds to dissolve the detergents.
7/ Add a strip of stained cloth to each beaker and start the stop watch.
8/ Stir each beaker once every ten seconds.
9/ Remove the cloth strips after 5 minutes
10/ Draw up a table to compare the effectiveness of each detergent in removing each stain.
11/ Score each detergent according to a scale.
0- poor , 1- fair , 2- good, 3- very good,
12/ Total the scores

Beaker	Sauce	Oil	Pen	Beet	Mud	Total Score
1						
2						
3						
4						

Result: Non of the detergents were very effective on axle sump oil. Water alone is partly effective with mud and sauce. All the detergents were better than water alone, one detergent being slightly better than the others.

Conclusion: While the test is fair it does not compare the effectiveness of the detergents in warm water, with different materials or the harshness of the detergent on the material. Some detergents contain sodium hydroxide making them effective on oils in cold water but this chemical also damages clothes and skin.

Risk Level: Low Hazard.: Some laundry detergents contain sodium hydroxide which is damaging to skin and eyes.

STUDENT:____________________

235

Window Cleaners

Aim: To produce and compare various window cleaning solutions.

Equipment

Hand sprayer
Dish washing detergent (in a dropper bottle)
Ammonia ,10%, (in a dropper bottle)
Methanol
Measuring Cylinder,100ml
Newspaper

Procedure

1/ Prepare the following three solutions:

Solution A	Solution B	Solution C
100ml water	100ml water	50ml water
10 drops detergent	10 drops detergent	10 drops detergent
	20 drops ammonia	50ml methanol

2/ Place 100ml of water in the hand sprayer. Spray one laboratory window and wipe dry with newspaper.
3/ Replace the water in the sprayer with solution A and clean another laboratory window.
4/ Replace solution A with solution B and clean another window.
5/ Replace solution B with solution C and clean one more window.
6/ Which solution cleans windows best?

- Which cleaning agent was the control in this experiment.
- List four things wrong with the procedure as a method for comparing window cleaners.

Results: ____________________

Conclusion: ____________________

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235

Window Cleaners

Topics: Consumer Science Scientific Method

Aim: To produce and compare various window cleaning solutions.

Equipment

Hand sprayer
Dish washing detergent (in a dropper bottle)
Ammonia ,10%, (in a dropper bottle)
Methanol
Measuring Cylinder,100ml
Newspaper

Procedure

1/ Prepare the following three solutions:

Solution A	Solution B	Solution C
100ml water	100ml water	50ml water
10 drops detergent	10 drops detergent	10 drops detergent
	20 drops ammonia	50ml methanol

2/ Place 100ml of water in the hand sprayer. Spray one laboratory window and wipe dry with newspaper.
3/ Replace the water in the sprayer with solution A and clean another laboratory window.
4/ Replace solution A with solution B and clean another window.
5/ Replace solution B with solution C and clean one more window.
6/ Which solution cleans windows best?

- Which cleaning agent was the control in this experiment.
- List four things wrong with the procedure as a method for comparing window cleaners.

-Water is the control liquid
Problems:
- The windows are not identically dirty
- The windows were not cleaned identically well
- Cleaness of windows is a "null result", that is success gives an absence of data.
- Cleaness of windows is subjective, that is it cannot be objectively measured
- There were no duplicates.

Result: Generally solution C gives the best result.

Conclusion: All the solutions will clean windows. It is not possible to determine which solution is best since judging clean windows is subjective and the windows were not identically dirty.

Risk Level: Low Hazard: Methanol is a flammable liquid. Ammonia is caustic affecting eyes and skin. Fumes from ammonia are pungent and can irritate eyes and lungs.

STUDENT:____________________

236

Forensic Science

Aim: To analyse the variation of thumb prints in the class

Equipment

Ink pad

Paper squares, 10X10cm

Procedure

1/ Write your name on the back of a peice of paper.

2/ Make a clear print on the front of the paper by inking your right thumb and then rolling it on the paper from left to right.

3/ Identify the "type" of your thumb print from the diagrams.

How many students in the class have plain arches? ____

How many students in the class have tented arches? ______

How many students in the class have whorls? ______

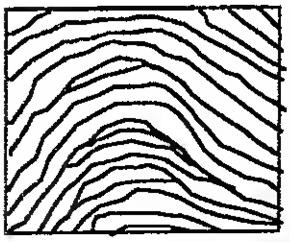
How many students in the class have simple loops? ______

How many students in the class have compoun loops? _____

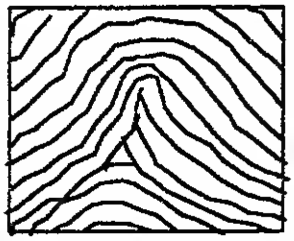
4/ Produce a bar graph in the space below which represents the proportions thumb print types in the class. Use a key.

5/ Divide into five goups depending on your thumb print type.

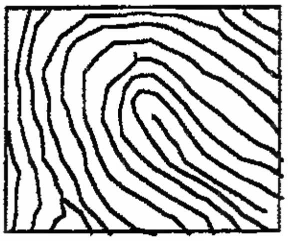
6/ Examine the prints and determine if any are identical.



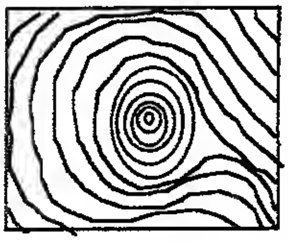
Plain Arch



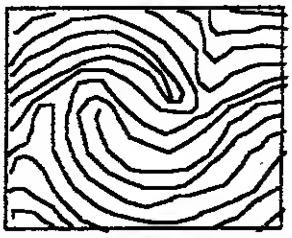
Tented Arch



Whorl



Simple Loop



Compound Loop

Results: ____

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Conclusion: ____

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236

Forensic Science

Topics: Scientific Method Genetics

Aim: To analyse the variation of thumb prints in the class

Equipment

Ink pad

Paper squares, 10X10cm

Procedure

1/ Write your name on the back of a piece of paper.

2/ Make a clear thumb print on the front of the paper by inking your right thumb and then rolling it on the paper from left to right.

3/ Identify the "type" of your thumb print from the diagrams below.

How many students in the class have plain arches? _____

How many students in the class have tented arches? _____

How many students in the class have whorls? _____

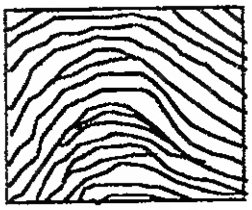
How many students in the class have simple loops? _____

How many students in the class have compound loops? _____

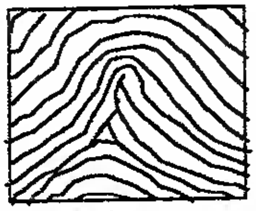
4/ Produce a bar graph in the space below which represents the proportions thumb print types in the class. Use a key.

5/ Divide into five groups depending on your thumb print type.

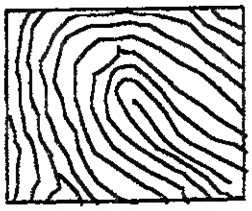
6/ Examine the prints and determine if any are identical.



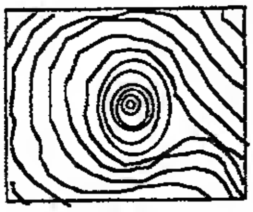
Plain Arch



Tented Arch



Whorl



Simple Loop

Compound Loop

Result: No two thumb prints in the class were identical (identical twins excepted).

Conclusion: While various types of thumb prints are apparent there is sufficient variation within types to say each print is unique.

Risk Level: Low Hazard:

STUDENT:__________________

237

Blind Spot

Aim: To verify that human eyes have a blind spot

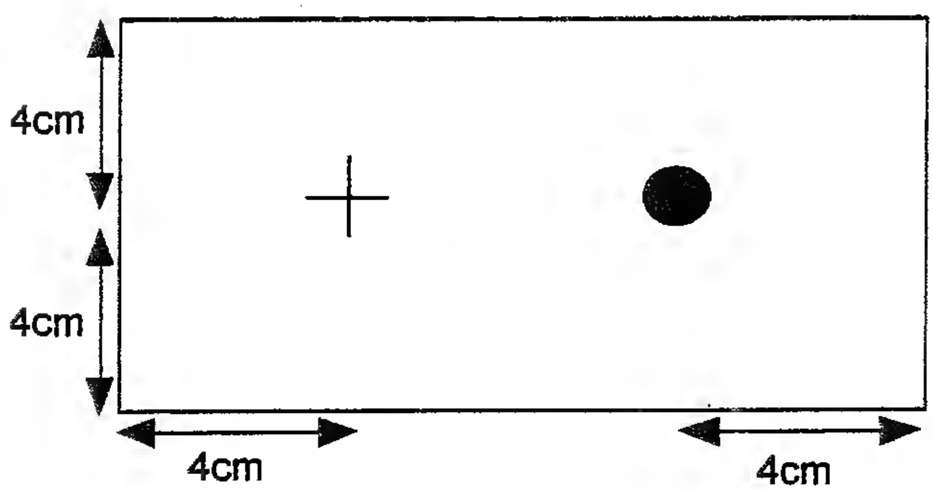
Equipment

Paper , 12cm X 8cm

Procedure

1/ Draw a 1cm black cross 4cm from the left , top, and bottom edges.
2/ Draw a 1cm black dot 4cm from the right, top and bottom edges.
3/ Hold your right eye closed with your right hand.
4/ Hold the paper in your left hand and about 30cm in front of your face.
5/ Concentrating on the black dot, slowly move the paper toward your face.

- Explain what happens to the black cross in terms of the physical structure of the human eye.
- Try to explain why this effect is not visible normally.



Results: ____

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Conclusion: ____

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237

Blind Spot

Topics: Coordination Light

Aim: To verify that human eyes have a blind spot

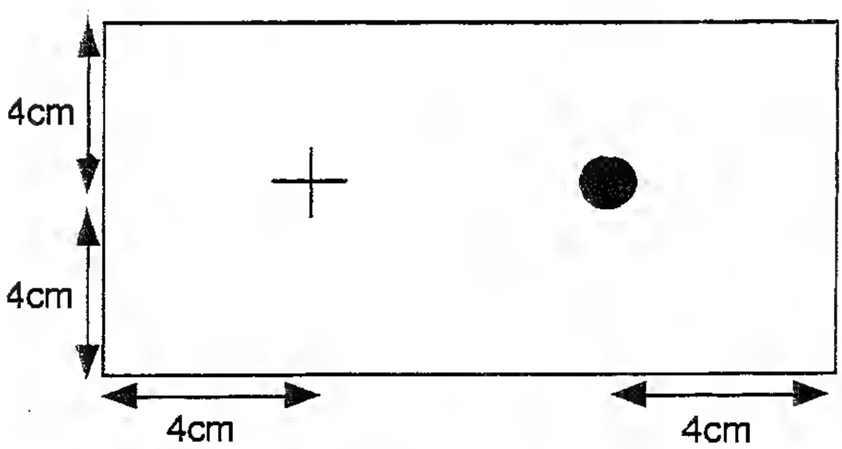
Equipment

Paper , 12cm X 8cm

Procedure

1/ Draw a 1cm black cross 4cm from the left , top, and bottom edges.
2/ Draw a 1cm black dot 4cm from the right, top and bottom edges.
3/ Hold your right eye closed with your right hand.
4/ Hold the paper in your left hand and about 30cm in front of your face.
5/ Concentrating on the black dot, slowly move the paper toward your face.

- Explain what happens to the black cross in terms of the physical structure of the human eye.
- Try to explain why this effect is not visible normally.



Result: The black dot disappears.

Conclusion: Where the optic nerve connects to the back of the eye there is a small circular gap in the light sensitive retina. An object focused on this "Bind Spot" in the retina is apparently invisible. Images from the eyes are processed by the brain which fills in details seen by one eye but not the other.

Risk Level: Low Hazard:

STUDENT:__________________

238

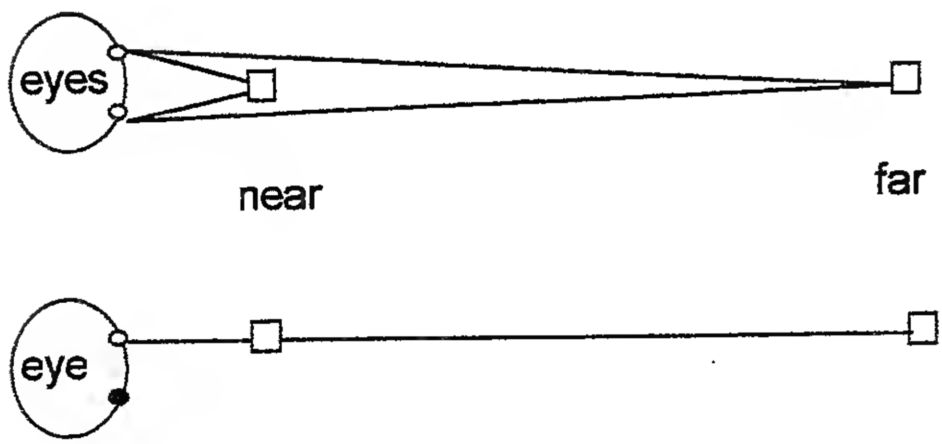
Depth Perception

Aim: To investigate the role of binocular vision in perceiving distance.

Equipment
None

Procedure
1/ Divide into pairs.
2/ One person, the subject, holds their right arm straight out to their side.
3/ The other person holds a ruler vertically about half a metre in front of the subject.
4/ The subject tries to swing their right hand in a smooth arc to touch the side of the ruler with their index finger.
5/ The experiment is repeated with the subject holding their left eye closed with their left hand.
6/ Swap roles of subject and experimenter then repeat the experiment.

- Examine the diagram below and then try to explain the result of your experiment.
- Why are one eyed people not allowed to drive a vehicle or pilot a plane.



Results: ____

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Conclusion: ______________________________________

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238

Depth Perception

Topics: Coordination Light

Aim: To investigate the role of binocular vision in perceiving distance.

Equipment
None

Procedure
1/ Divide into pairs.
2/ One person, the subject, holds their right arm straight out to their side.
3/ The other person holds a ruler vertically about half a metre in front of the subject.
4/ The subject tries to swing their right hand in a smooth arc to touch the side of the ruler with their index finger.
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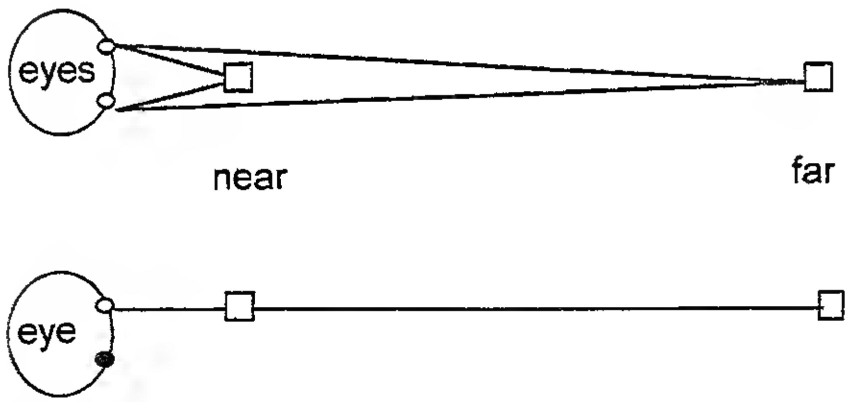
- Why are one eyed people not allowed to drive a vehicle or pilot a plane.



Result: With both eyes open the subject could easily touch the side of the ruler. With one eye closed the subject missed the ruler, their finger passing in front or behind by one or two centimetres.

Conclusion: When both eyes focus on a near object a triangle is formed with smaller base angles than for a distant object. The eyes **triangulate** the distance to the object by their angle relative to each other. One eye alone sees no difference in angle between near and far objects. One eyed people are not allowed to drive since they cannot accurately judge stopping distance.

Risk Level: Low hazard:

STUDENT:________________

Learning

Aim: To observe Piaget comprehension stages in young students.

Equipment

Arrangement to visit a class of students aged 6 and a class aged 11.
Teams 1 and 2:
Measuring cylinder, 100ml
Beaker, 400ml
Teams 3 and 4:
match boxes,empty, seven
matches, seven
Teams 5 and 6:
Moral Conundrum

Procedure

Piaget was an educationalist who recognised particular cognitive (mental processing) stages in children.

1/ The teacher divides the class into six teams.

2/ Teams 1 and 2 will each test a different group of three, 6 year old childen for "Volume Cognition": Fill the beaker and measuring cylender with water and ask which contains the most water.

3/ Teams 3 and 4 will test separate groups of three, 6 year old students for " Number Conservation" : The students are shown each match box contains one match. The matches are removed and placed in a pile while the match boxes are placed in a separate pile. The students are asked "Which pile has more things in it?"

4/ Teams 4 and 6 ask test separate groups of six year olds for "Moral Cognition" with a question: "If one boy breaks six dishes when washing up and another boy breaks one dish while being naughty, which boy is baddest?"

5/ Teams rotate twice between the test groups.

6/ Rotate tasks and then test 11 year old students.

Age Group	Volume	Number	Moral
6			
6			
6			
11			
11			
11			

Use a tick for each correct reponse and a cross for each incorrect response.

Results: ____

____

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Conclusion: ____

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239

Learning

Topics: Coordination

Aim: To observe Piaget comprehension stages in young students.

Equipment

Arrangement to visit a class of students aged 6 and a class aged 11.

Teams 1 and 2:
Measuring cylinder, 100ml
Beaker, 400ml

Teams 3 and 4:
match boxes,empty, seven
matches, seven

Teams 5 and 6:
Moral Conundrum

Test your students: One boy tells another " Break that window or I will break your face". Who is to blame? (eg. war crimes).

Procedure

Piaget was an educationalist who recognised particular cognitive (mental processing) stages in children.

1/ The teacher divides the class into six teams.

2/ Teams 1 and 2 will each test a different group of three, 6 year old children for "Volume Cognition": Fill the beaker and measuring cylinder with water and ask which contains the most water.

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5/ Teams rotate twice between the test groups.

6/ Rotate tasks and then test 11 year old students.

Age Group	Volume	Number	Moral
6			
6			
6			
11			
11			
11			

Use a tick for each correct reponse and a cross for each incorrect response.

Result: Six year old children will mostly fail all three tests unless guessing. Eleven year old children have volume cognition and number conservation but are still developing moral cognition.

Conclusion: Young children can estimate only one dimension at a time, height being dominant. Size estimate overrides the abstract concept of number. Moral cognition is difficult and is overridden by number sense. Cognition of space, number, and rightness are achieved at different stages of mental development.

Risk Level: Low hazard: Students must be primed to be sensitive to the younger students avoiding any comment on their answers, especially words such as dumb, stupid etc.

STUDENT:________________

240

Antigravity

Aim: To demonstrate that air pressure can support a column of water.

Equipment

Test tube

Writing paper, 5cmX5cm

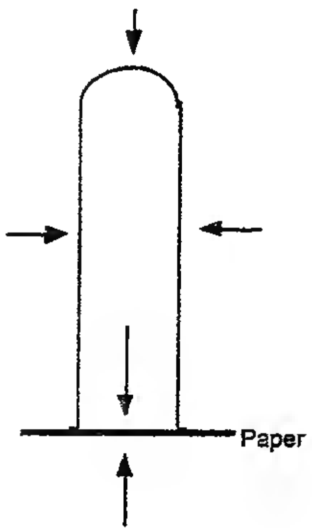
Procedure

1/ Fill a test tube with water to the very top.

2/ Slide the paper over the top of the test tube, carefully trying to exclude any air bubbles between the water and the paper.

3/ Slowly invert the test tube.

- On the diagram below arrows have been drawn indicating the forces in action. Label the arrows (the same label may be used more than once).



Results: ______________________________

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Conclusion: ______________________________

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240

Antigravity

Topics: Density & Pressure

Aim: To demonstrate that air pressure can support a column of water.

Equipment

Test tube

Writing paper, 5cmX5cm

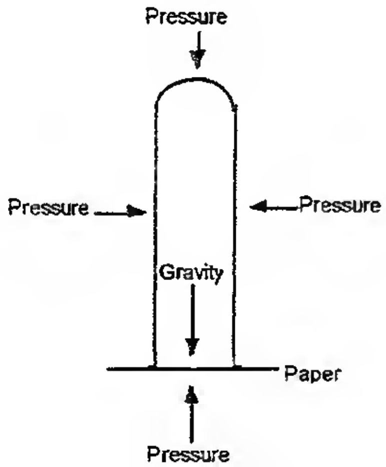
Procedure

1/ Fill a test tube with water to the very top.

2/ Slide the paper over the top of the test tube, carefully trying to exclude any air bubbles between the water and the paper.

3/ Slowly invert the test tube.

- On the diagram below arrows have been drawn indicating the forces in action. Label the arrows (the same label may be used more than once).



Result: The water does not fall out of the test tube.

Conclusion: On three sides air pressure is acting on the test tube. On the final side, air pressure is acting on the water surface. The air pressure acting on the surface is sufficient to counter the gravitational force on the water thus preventing its fall. Without paper the water is free to flow out by deforming its surface.

Risk Level: Low Hazard:

STUDENT:________________

241 Fire Alarm

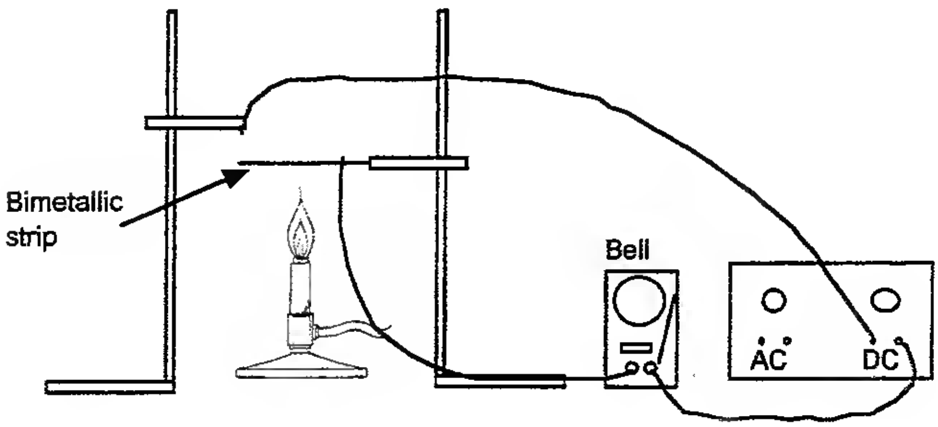
Aim: To make an alarm that automatically turns on in the presence of fire.

Equipment

Power Supply, 0-12V
Electric Bell
Bimetallic strip
Connecting Wires,three
Retort stands, two
Boss head & clamps, two
Bunsen
Alligator clip

Procedure

1/ Using connecting wire link a DC terminal of the power supply to a terminal of the electric bell.
2/ Using an alligator clip and connecting wire, link the bimetallic strip to the other terminal on the bell.
3/ Using a retort stand and clamp, support the bimetallic strip about 5cm above the Bunsen. The strip should be parallel to the desk , broad side facing the Bunsen.
4/ Using the second retort stand, support one end of the final connecting lead about 2cm above the end of the bimetallic strip.
5/ Link the free end of the last connecting lead to the other DC terminal of the power supply.
6/ Set the power supply to 12 DC and light the Bunsen.
7/ If the bimetallic strip begins to bend downward, remove the Bunsen and turn over the bimetallic strip.



Results: ____

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Conclusion: ____

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241

Fire Alarm

Topics: electricity Kinetic Theory Matter

Aim: To make an alarm that automatically turns on in the presence of fire.

Equipment

Power Supply, 0-12V
Electric Bell
Bimetallic strip
Connecting Wires,three
Retort stands, two
Boss head & clamps, two
Bunsen
Alligator clip

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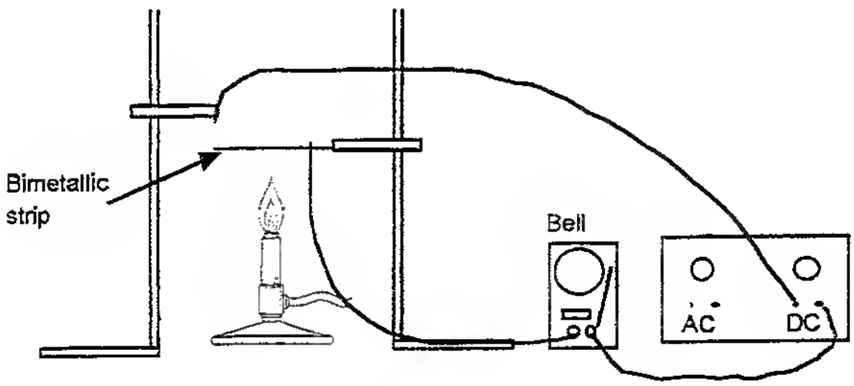

Result: The bell rings when the Bunsen flame heats the bimetallic strip.

Conclusion: The bimetallic strip has two different metal layers that expand at different rates. When heated on one side the bimetallic strip bends until its tip touches the connecting lead above and so completes the circuit. The alarm rings in the presence of strong heat.

Risk Level: Low Hazard:

STUDENT:____________________

242

Fuel Cell

Aim: To make and test a simple fuel cell.

Equipment

Test Tubes, 4ml, two
Carbon Rods, two
Retort Stand
Ring Clamp
Alligator clips, two
Silicone glue
Connecting wires, two
Power supply, 0 -12V
Lamp, 2V
Polystyrene cup
Sulfuric Acid, 0.1M, 0.5%

Procedure

- Draw the apparatus set up by the teacher.

- If one tube contains oxygen and the other hydrogen write the half cell reactions you would expect to be taking place.

- Write the overall equation for the reaction.

- How is a fuel cell different from a battery (think in terms of supply of the two gasses).

Results: ____

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Conclusion: ____

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242

Fuel Cell

Topics: Electricity Ions

Aim: To make and test a simple fuel cell.

Equipment

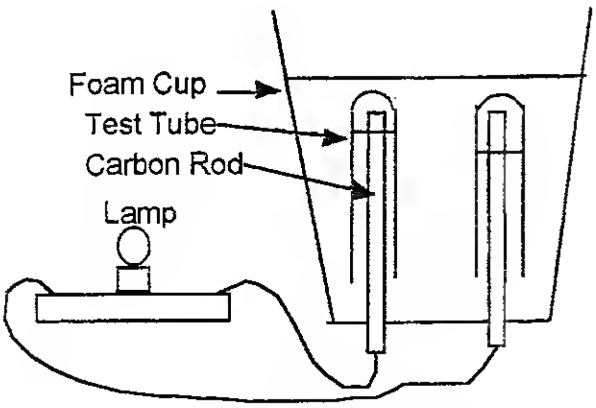
Test Tubes, 4ml, two
Carbon Rods, two
Retort Stand
Ring Clamp
Alligator clips, two
Silicone glue
Connecting wires, two
Power supply, 0 -12V
Lamp, 2V
Polystyrene cup
Sulfuric Acid, 0.1M, 0.5%

The construction time requirements make this experiment more suitable as a teacher demonstration.

Procedure

A fuel cell is a device which produces an electric current from ion reactions similar to a battery (galvanic cell) however the reactants can be continuously supplied to **fuel** the reaction.

1/ Make two holes in the base of the foam cup.
2/ Place the cup in the ring clamp on the retort stand.
3/ Insert the carbon rods into the holes so they deeply protrude into the cup.
4/ Seal the carbon rods in place with silicone glue.
5/ When the glue is set, three quarter fill the cup with dilute acid so the electrodes are covered.
6/ Fill the two semi-micro test tubes with dilute acid then invert each over a carbon electrode.
7/ Connect the protruding bases of the carbon rods to the DC terminals of the power supply.
8/ Set the power supply to 6V and leave running until sufficient gas has been collected in the tubes to partly expose the carbon rods (about 1 hour).
9/ Disconnect the leads from the power supply and connect across the lamp or a small model electric motor.



Result: A strong electric current was produced by the fuel cell.

Conclusion: Half cell reactions are taking place:

Cathode, $O_2 + 4e^- > 2O^{2-}$ Anode, $H_2 > 2H^+ + 2e^-$

In a battery the reactions cease when the reactants have been consumed. In a fuel cell the reactants can be continually supplied maintaining the current.

Risk Level: Low Hazard:

STUDENT:__________________

243 Physics Prac

Aim: To test practical skills involved in electrical circuits.

Equipment

Breadboard, plastic
Battery, 9V
Phillips screw driver
Screws and washers,4
Battery clip
Resistor,
(Brown/Black/Black)
Solenoid
Switch
Light emitting diode
Multimetre
Connecting wires, 2 , 10cm

Procedure

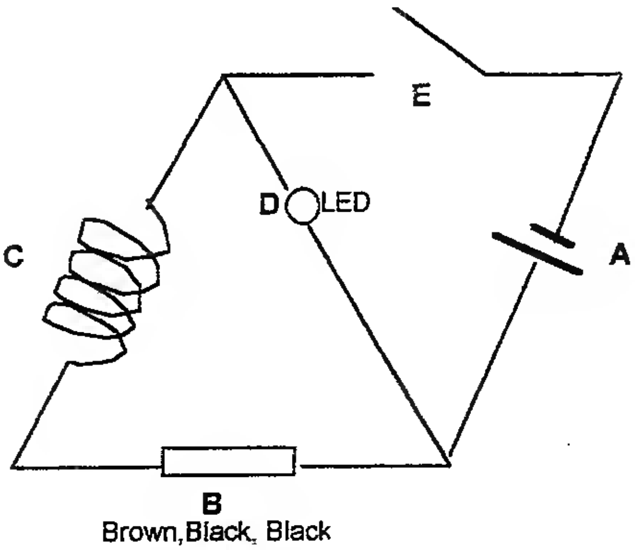
1/ From the circuit diagram below, name the components labelled A,B,C,D,E.

2/ On the circuit diagram draw the following:
a) The positive (+) and negative (-) sides of the battery.
b) The colour of the wires leading to the battery.
c) The direction of electron flow (e)
d) The direction of current flow (I)
e) The direction of magnetic field of the solenoid (*B*)
f) A meter measuring voltage across C
g) A meter measuring current flow in C

3/ Determine whether the following component pairs are in series or parallel:
a) Components C and D. b) Components C and B .
c) Components B and D. d) Components E and B .

4/ BUILD THE CIRCUIT:

8/ Using a multimetre, measure the following:
a) The resistance of B. b) The Voltage Drop across B.c) The current flowing through C.



Results: ______________________________

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Conclusion: ______________________________

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243

Physics Prac

Topics: Electricity

Aim: To test practical skills involved in electrical circuits.

Equipment

Breadboard, plastic
Battery, 9V
Phillips screw driver
Screws and washers,4
Battery clip
Resistor,
(Brown/Black/Black)
Solenoid
Switch
Light emitting diode
Multimetre
Connecting wires, 2 , 10cm

Procedure

1/ From the circuit diagram below, name the components labelled A,B,C,D,E.

2/ On the circuit diagram draw the following:

a) The positive (+) and negative (-) sides of the battery.
b) The colour of the wires leading to the battery.
c) The direction of electron flow (e)
d) The direction of current flow (I)
e) The direction of magnetic field of the solenoid (*B*)
f) A meter measuring voltage across C
g) A meter measuring current flow in C

3/ Determine whether the following component pairs are in series or parallel:

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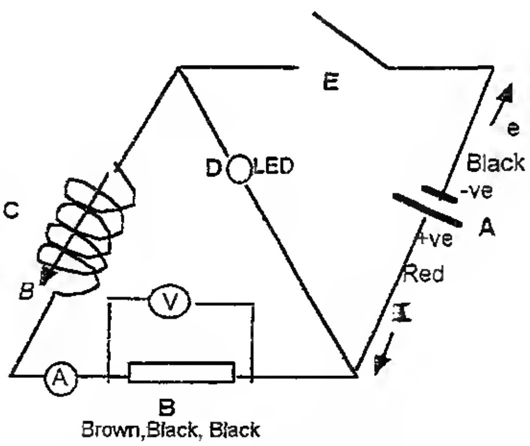


Result: A= Battery, B= Resistor, C= solenoid, D= Light Emitting Diode, E= switch. C and D are in parallel. C and B are in series. B and D are in parallel. E and B are in series.

Conclusion: Resistance of B is about 10 ohms, Voltage drop across B is about 2V, Current flowing in C is about 200 mAmp.

Risk Level: Low Hazard: Only use fresh batteries and caution the students to leave the switch off when not making measurements.

STUDENT:____________________

244 Series and Parallel

Aim: To examine the differences between series and parallel circuits.

Equipment

Power Supply, 0-12V, DC
Connecting wires,five
Lamp bases, two

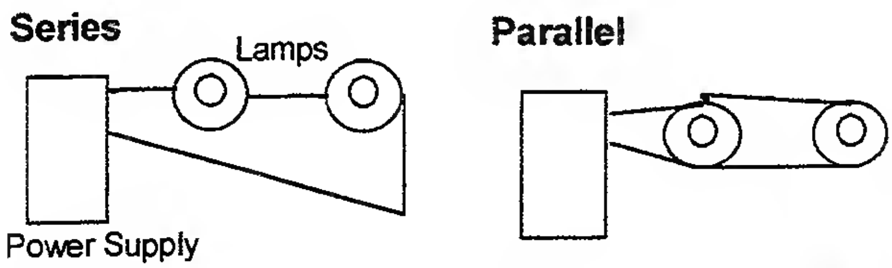
Optional: Multimeter to record voltage and current across each lamp.

Procedure

1/ Connect the lamps and power supply in series as shown in the diagram below.
2/ Set the power supply to 12V and record whether the lamps glow brightly, dimly or not at all.
3/ Unscrew one lamp and record the effect on the other lamp.
4/ Rearrange the connecting wires so the lamps are in parallel.
5/ Record how the lamps are glowing.
6/ Unscrew one lamp and record the effect on the other lamp.

- What is a disadvantage of series circuits?
- What is an advantage of series circuits?

Option: Measure the voltage and current across each lamp when in series and when in parallel. Measure the resistance in each circuit.



	Lamp 1	Lamp2
Series		
Series (one unscrewed)		
Parallel		
Parallel (one unscrewed)		

Results: ____

____

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Conclusion: ____

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244

Series and Parallel

Topics: Electricity

Aim: To examine the differences between series and parallel circuits.

Equipment

Power Supply, 0-12V, DC
Connecting wires,five
Lamp bases, two

Optional: Multimeter to record voltage and current across each lamp.

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1/ Connect the lamps and power supply in series as shown in the diagram below.
2/ Set the power supply to 12V and record whether the lamps glow brightly, dimly or not at all.
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6/ Unscrew one lamp and record the effect on the other lamp.

- What is a disadvantage of series circuits?
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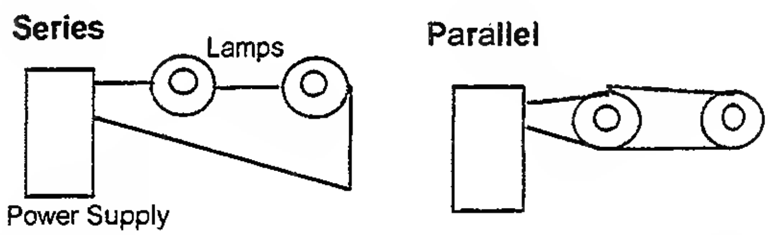
Option: Measure the voltage and current across each lamp when in series and when in parallel. Measure the resistance in each circuit.



	Lamp 1	Lamp2
Series		
Series (one unscrewed)		
Parallel		
Parallel (one unscrewed)		

Result: The lamps in series glowed dimly and when one globe was unscrewed the other went out. In parallel the lamps glowed brightly and when one lamp was unscrewed the other only dimmed slightly.

Conclusion: Series circuits require less wiring however if one component fails the whole circuit fails. In parallel circuits the current travels in each parallel path so when one component fails, current still flows to the other components. (Voltage across parallel components is higher, the current flow is higher and the total resistance is lower.)

Risk Level: Low Hazard:

STUDENT:________________

245

Shock Stack

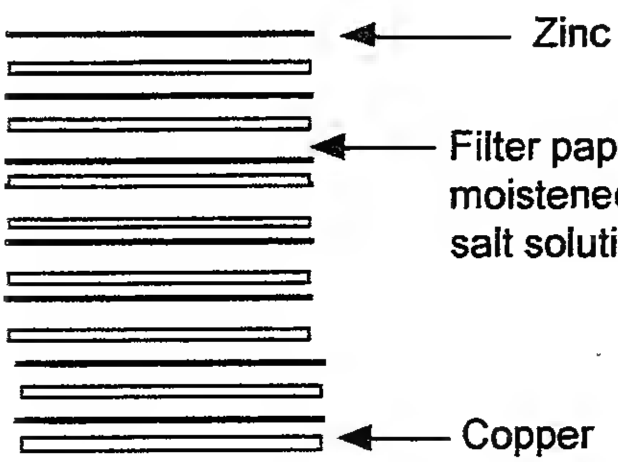
Aim: To create a simple, compact power source

Equipment

Copper sheet,2X2cm,eight
Filter Paper, 2X2cm, twenty
Zinc sheet (galvanised iron) , 2X2cm, eight
Sodium Chloride
Beaker, 250ml
Dropper bottle
Balance, 0.1g sensitivity
connecting wire
Measuring cylinder,100ml
stirring rod

Procedure

1/ Weigh 3g of sodium chloride into a beaker.
2/ Add 100ml of water and dissolve the salt.
3/ Fill the dropper bottle with salt solution
4/ Place a copper copper square on the bench.
5/ Place a filter paper square on the copper square.
6/ Add two drops of salt solution to the filter paper.
7/ Place a zinc square on the moist paper.
8/ Place another peice of filter paper on the stack and moisten it with salt solution.
9/ Continue building the stack with altemate peices of copper and zinc sheet separated by moistenned filter paper.
10/ Turn the stack on its side holding it together with a figer of one hand on the copper base and a finger of the opposite hand on the zinc top.
11/ Do you feel anything?



Results: ____

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Conclusion: ____

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TEACHER COPY

245

Shock Stack

Topics: Electricity Ions

Aim: To create a simple, compact power source

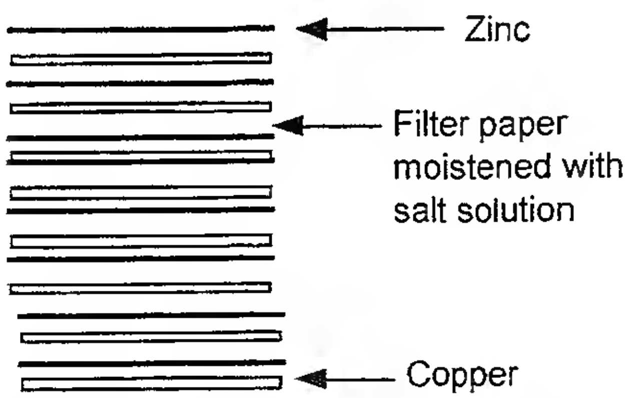
Equipment

Copper sheet,2X2cm,eight
Filter Paper, 2X2cm, twenty
Zinc sheet (galvanised iron), 2X2cm, eight
Sodium Chloride
Beaker, 250ml
Dropper bottle
Balance, 0.1g sensitivity
connecting wire
Measuring cylinder,100ml
stirring rod

The metal sheets should be cleaned beforehand by brief immersion in 4M sulfuric acid and rinsing in water.

Procedure

1/ Weigh 3g of sodium chloride into a beaker.
2/ Add 100ml of water and dissolve the salt.
3/ Fill the dropper bottle with salt solution
4/ Place a copper copper square on the bench.
5/ Place a filter paper square on the copper square.
6/ Add two drops of salt solution to the filter paper.
7/ Place a zinc square on the moist paper.
8/ Place another piece of filter paper on the stack and moisten it with salt solution.
9/ Continue building the stack with alternate pieces of copper and zinc sheet separated by moistened filter paper.
10/ Turn the stack on its side holding it together with a finger of one hand on the copper base and a finger of the opposite hand on the zinc top.
11/ Do you feel anything?



Result: A slight tingling is felt holding the stack ends with the fingers of opposite hands.

Conclusion: An voltaic cell (battery) is created by two dissimilar metals linked by a salt solution. Creating a stack of alternating metals and salt solution increases the power (voltage) of the combined voltaic cells.

Risk Level: Mild Hazard: No students with bionic aids should attempt this experiment.

STUDENT:____________________

246 Power

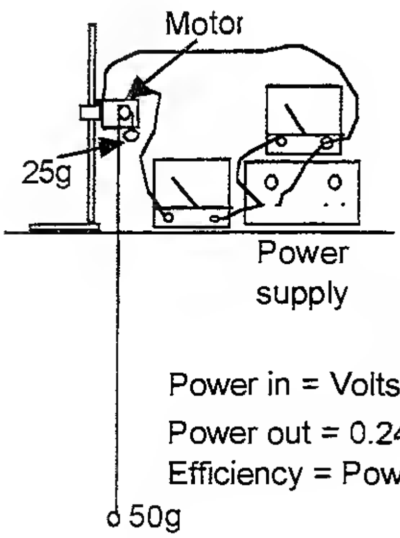
Aim: To determine the power efficiency of an electric motor.

Equipment

Retort Stand
Clamp and boss head
Power supply, 0-12V DC
Electric Motor, 6V DC
Connecting wires, five
Multimeter (or Voltmeter 0-10V and Ammeter 0-5A)
Stop watch
Metre rule
String (1.2m)
Masses, 50g and 25g

Procedure

1/ Clamp the electric motor on the retort stand at the edge of the bench and one metre from the floor.
2/ Tie a 50g mass on one end of the string and the 25g mass at the other end.
3/ Drape the string over the moter spindle so the 50g mass is on the floor and the 25g mass one metre above.
4/ Connect the motor to the ammeter and the positive ammeter terminal to the positive DC terminal of the power supply.
5/ Link the negative DC power supply terminal back to the motor. Connect the voltmeter across the power terminals.
6/ Set the power supply to 6V. When the power is turned on record how long it takes for the 50g mass to be raised 1 metre as well as the voltage and current flowing.
7/ Repeat step 6 four times.
Power = work done / second, Electric Power = Volts X Amps
Mechanical Work : PE gained = mgh = 0.245 Watts,
Plus KE gained = $1/2mv^2 = 0.15 / t^2$



Trial	Volts	Amps	Time
1			
2			
3			
4			
5			
Average			

Power in = Volts X Amps = ________Watts
Power out = $0.245 + (0.15/ t^2)$= ______Watts
Efficiency = Power out / power in X 100 = _____%.

Results: ____

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Conclusion: ____

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246

Power

Topics: Electromagnetism Energy Machines

Aim: To determine the power efficiency of an electric motor.

Equipment

Retort Stand
Clamp and boss head
Power supply, 0-12V DC
Electric Motor, 6V DC
Connecting wires, five
Multimeter (or Voltmeter 0-10V and Ammeter 0-5A)
Stop watch
Metre rule
String (1.2m)
Masses, 50g and 25g

Procedure

1/ Clamp the electric motor on the retort stand at the edge of the bench and one metre from the floor.
2/ Tie a 50g mass on one end of the string and the 25g mass at the other end.
3/ Drape the string over the motor spindle so the 50g mass is on the floor and the 25g mass one metre above.
4/ Connect the motor to the ammeter and the positive ammeter terminal to the positive DC terminal of the power supply.
5/ Link the negative DC power supply terminal back to the motor. Connect the voltmeter across the power terminals.
6/ Set the power supply to 6V. When the power is turned on record how long it takes for the 50g mass to be raised 1 metre as well as the voltage and current flowing.
7/ Repeat step 6 four times.
Power = work done / second, Electric Power = Volts X Amps
Mechanical Work : PE gained = mgh = 0.245 Watts,
Plus KE gained = $1/2mv^2 = 0.15 / t^2$

KE gained = $1/2 \times 0.075 \times v^2$

$v^2 = u^2 + 2as = 2a$

$s = ut + 1/2at^2 = 1/2at^2$

$a = 2/t^2$

$v^2 = 4/t^2$

$KE = 0.0375 \times 4 / t^2 = 0.15/t^2$

Result: Efficiencies as low as 3% are to be expected.

Conclusion: Many devices have poor power efficiencies. Most of the power loss occurs as heat. Laboratory model electric motors are designed so the internal workings can be seen and so the outer magnet windings are restricted to one side, guaranteeing a poor efficiency.

Risk Level: Low Hazard:

STUDENT:________________

247

Electric Wind

Aim: To demonstrate that a flame contains charged particles.

Equipment

Van De Graaf Generator
Connecting Wire
Bunsen
Wooden test tube peg

Procedure

- Place a connecting wire in the dome plug of the Van De Graaf generator.
- Start the generator
- Light a Bunsen within reach of the connecting wire and adjust to a yellow flame.
- Use the test tube peg to grasp the free end of the connecting wire.
- Bring the connecting wire near the side of the Bunsen flame.
- Draw the apparatus and result in the space below.

Hint: Van De Graaf generators produce large positive charges.

Results: ____

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Conclusion: ____

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247

Electric Wind

Topics: Electrostatics Ions

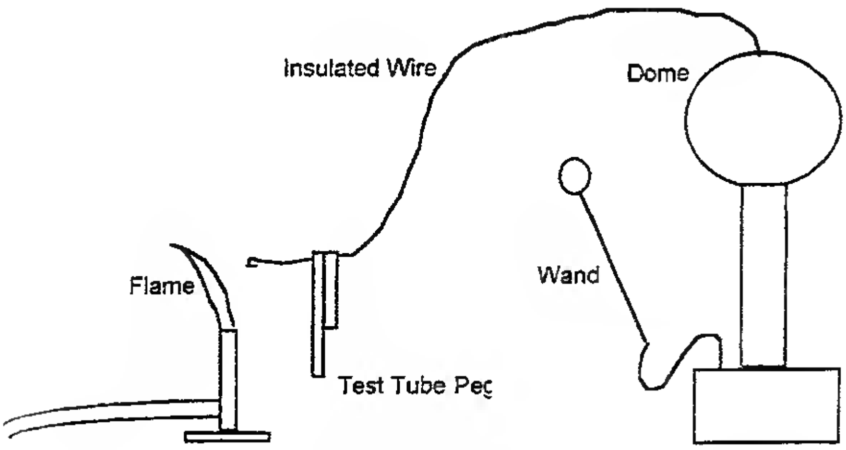
Aim: To demonstrate that a flame contains charged particles.

Equipment

Van De Graaf Generator
Connecting Wire
Bunsen
Wooden test tube peg

Procedure

- Place a connecting wire in the dome plug of the Van De Graaf generator.
- Start the generator
- Light a Bunsen within reach of the connecting wire and adjust to a yellow flame.
- Use the test tube peg to grasp the free end of the connecting wire.
- Bring the connecting wire near the side of the Bunsen flame.



Result: The Bunsen flame is repelled by the connecting wire as if blown by a wind.

Conclusion: The coloured part of a flame contains positive ions.

Risk Level: Moderate Hazard:

STUDENT:_______________

248 Electron Attractions

Aim: To observe some reactions due to electrostatic force.

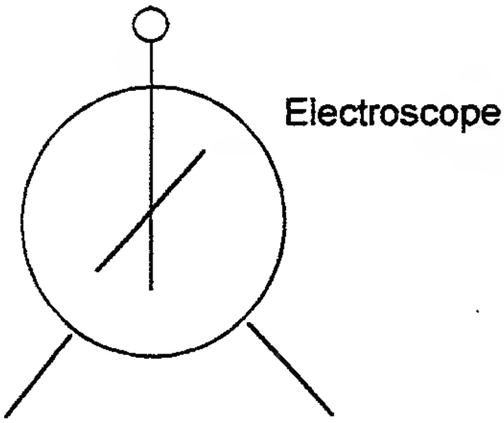
Equipment

Perspex Rod
Ebonite Rod
Dry cloths, two
Balloons, two
String, 50cm, two
Electroscope

Note: When a perspex rod is rubbed with a cloth, negatively charged electrons are lost to the cloth leaving the rod with a net positive charge.

Procedure

1/ Inflate two balloons and attach a peice of string to each
2/ Rub the balloons vigourously with a cloth (charging).
3/ Suspend the balloons by their strings and bring one balloon close to the other. Record anything unusual.
4/ Bring a charged perpex rod close to the side of the balloons. Record the result.
5/ Bring a charged ebonite rod (use a separate cloth) close to the balloons and record any result.
6/ Charge a perspex rod and briefly bring it close the terminal of an electroscope.
7/ Touch the electroscope terminal with a charged perspex rod then withdraw the rod. Record any difference from step 7.
8/ Touch the charged electroscope with your finger.
- What is the charge of the balloons?
- What is the charge of an ebonite rod?
- What can you conclude about the forces between charges?



Results: _______________

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Conclusion: _______________

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248

Electron Attractions

Topics: Electrostatics

Aim: To observe some reactions due to electrostatic force.

Equipment

Perspex Rod
Ebonite Rod
Dry cloths, two
Balloons, two
String, 50cm, two
Electroscope

Note: When a perspex rod is rubbed with a cloth, negatively charged electrons are lost to the cloth leaving the rod with a net positive charge.

Electrostatic experiments require low humidity.

Procedure

1/ Inflate two balloons and attach a piece of string to each
2/ Rub the balloons vigorously with a cloth (charging).
3/ Suspend the balloons by their strings and bring one balloon close to the other. Record anything unusual.
4/ Bring a charged perspex rod close to the side of the balloons. Record the result.
5/ Bring a charged ebonite rod (use a silk cloth) close to the balloons and record any result.
6/ Charge a perspex rod and briefly bring it close the terminal of an electroscope.
7/ Touch the electroscope terminal with a charged perspex rod then withdraw the rod. Record any difference from step 7.
8/ Touch the charged electroscope with your finger.
- What is the charge of the balloons?
- What is the charge of an ebonite rod?
- What can you conclude about the forces between charges?

Result: The balloons repel each other and are attracted to a perspex rod but repelled by the ebonite. The electroscope deflects when near a charge and stays deflected if the charge contacts. Finger contact neutralises the charge.

Conclusion: The balloons acquire a positive charge. The ebonite rod acquires a negative charge. Similar charges repel each other but opposite charges attract.

Risk Level: Low Hazard.

STUDENT:________________

Corrosion

Aim: To investigate the conditions affecting for the corrosion of iron.

Equipment
Test tube rack
test tubes, medium, six
Nails, 25mm, six
Steel wool
Cooking oil
Zinc Granules
Copper strip

Procedure
1/ Clean each nail with steel wool.
2/ Place the test tubes in the rack and a nail in each tube.
3/ Add 3cm of oil to the second tube.
4/ Add 3cm of water to the third tube.
5/ Add 3cm of water and then 1cm of oil to the fourth tube.
6/ Add a peice of zinc and 3cm of water to the fifth tube.
7/ Add a peice of copper and 3cm of water to the last tube.
8/ Leave the test tubes for one week
9/ Compare the rust formation in the tubes.

- What is the purpose of the conditions in each test tube?

Tube	Purpose	Corrosion
1		
2		
3		
4		
5		
6		

Results: ____

____

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Conclusion: ____

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249

Corrosion

Topics: Elements Chemical Runs

Aim: To investigate the conditions affecting for the corrosion of iron.

Equipment

Test tube rack
test tubes, medium, six
Nails, 25mm, six
Steel wool
Cooking oil
Zinc Granules
Copper strip

Procedure

1/ Clean each nail with steel wool.
2/ Place the test tubes in the rack and a nail in each tube.
3/ Add 3cm of oil to the second tube.
4/ Add 3cm of water to the third tube.
5/ Add 3cm of water and then 1cm of oil to the fourth tube.
6/ Add a piece of zinc and 3cm of water to the fifth tube.
7/ Add a piece of copper and 3cm of water to the last tube.
8/ Leave the test tubes for one week
9/ Compare the rust formation in the tubes.

- What is the purpose of the conditions in each test tube?

Tube	Purpose	Corrosion
1	Does rusting require air but not water?	
2	Does rusting occur without air or water?	
3	Does rusting require air and water?	
4	Does rusting require water but not air?	
5	Is rusting accelerated by a more active metal?	
6	Is rusting accelerated by a less active metal?	

Result: No corrosion was apparent in tubes 1, 2, and 5. Only limited corrosion occurred in tube 4, tube three exhibited corrosion and tube 6 was strongly corroded.

Conclusion: Corrosion of iron (rust) is oxidation of iron to iron oxide. Oxygen is required as a reactant and water is needed as a medium for the ions to form and react. Zinc is more reactive and undergoes sacrificial corrosion, protecting the iron. Copper is less reactive than iron and stimulates sacrificial corrosion of the iron.

Risk Level: Low Hazard.

STUDENT:____________________

250 Elastic Energy

Aim: To observe energy changes in an elastic band.

Equipment

Rubber band (No 11)

Procedure

There are three types of energy which can be interchanged in a rubber band: Elastic Potencial Energy, Kinetic Energy and Heat Energy

1/ Hold the rubber band between the the thumb and forefinger of both hands.
2/ Place the rubber band against your lower lip.
3/ Stretch the rubber band and while taught, place it against your lower lip.
4/ Relax the tension in the band while holding it against your lip.

- Describe the energy transformation which would take place if the rubber band were stretched over the tip of a ruler and then released.
- Describe an energy transformation taking place as the band is stretched.
- Will a band fly further if stretched and immediately released than if stretched, held a while and then released. Why?

Results: ____

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Conclusion: ____

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250

Elastic Energy

Topics: Energy

Aim: To observe energy changes in an elastic band.

Equipment

Rubber band (No 11)

Procedure

There are three types of energy which can be interchanged in a rubber band: Elastic Potential Energy, Kinetic Energy and Heat Energy

1/ Hold the rubber band between the the thumb and forefinger of both hands.
2/ Place the rubber band against your lower lip.
3/ Stretch the rubber band and while taught, place it against your lower lip.
4/ Relax the tension in the band while holding it against your lip.

- Describe the energy transformation which would take place if the rubber band were stretched over the tip of a ruler and then released.
- Describe an energy transformation taking place as the band is stretched.
- Will a band fly further if stretched and immediately released than if stretched, held a while and then released. Why?

Result: The rubber band is warmer when stretched and cooler when relaxed.

Conclusion: As a rubber band is stretched it stores elastic potential energy and if the band is suddenly released the energy is converted into kinetic energy as the band flies off. However when the band is stretched, some of the elastic potential energy is converted to heat energy which can be transmitted away, so pausing before releasing the band ensures it will not fly as far.

Risk Level: Low Hazard: There is sure to be some launching of rubber bands, the trick is not to let it get out of control.

STUDENT:________________

251 Power

Aim: To measure the energy output of a simple circuit and so derive its power in Watts.

Equipment

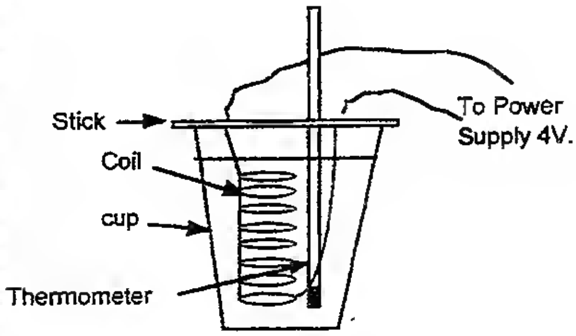
Power Supply, DC 0 - 12V
Connecting Leads, two
Alligator clips, two
Nichrome wire, 0.5m
Foam Cup
Thermometer, 0-100
Paddle Pop stick
Measuring Cylinder, 100ml

Optional: Multimeter

Procedure

1/ Wind the nichrome wire in even coils around a finger.
2/ Use an alligator clip on a to clamp one end of the coil to the paddle pop stick.
3/ Unwind 3 loops at the opposite end of the coil, straighten the wire and clip it back to the paddle pop stick with an alligator clip.
4/ Lower the nichrome coil into the foam cup.
5/ Measure water into the foam cup until the coil is covered.
6/ Record the temperature of the water.
7/ Use the connecting leads to join the alligator clips to the DC terminals of the power supply.
8/ Set the voltage to 4V and turn on the power for 300 seconds.
9/ Record the new temperature of the water.
10/ Calculate the energy released by the circuit from:
Heat Energy (Joules) = Temperature Change X Water Volume (ml) X 4.180 (Heat Capacity)
11/ Calculate the power output from:
Power (Watts) = Energy / Time (seconds)

Record	Figure
Water Vol.	
First temp.	
Final Temp.	
Energy	
Power	



Results: ____

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Conclusion: ____

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251

Power

Topics: Energy Electricity

Aim: To measure the energy output of a simple circuit and so derive its power in Watts.

Equipment

Power Supply, DC 0 - 12V
Connecting Leads, two
Alligator clips, two
Nichrome wire, 0.5m
Foam Cup
Thermometer, 0-100
Paddle Pop stick
Measuring Cylinder, 100ml

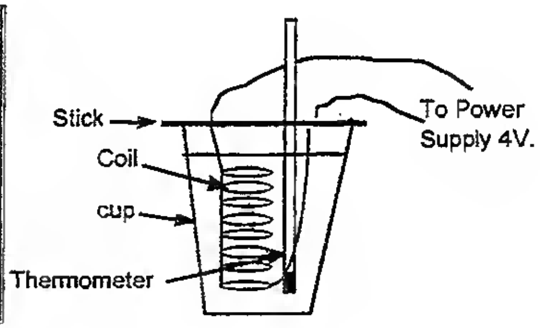
Optional: Multimeter

The Power Output can be confirmed by measuring the voltage and current of the circuit and using P=VI.

Procedure

1/ Wind the nichrome wire in even coils around a finger.
2/ Use an alligator clip to clamp one end of the coil to the paddle pop stick.
3/ Unwind 3 loops at the opposite end of the coil, straighten the wire and clip it back to the paddle pop stick with an alligator clip.
4/ Lower the nichrome coil into the foam cup.
5/ Measure water into the foam cup until the coil is covered.
6/ Record the temperature of the water.
7/ Use the connecting leads to join the alligator clips to the DC terminals of the power supply.
8/ Set the voltage to 4V and turn on the power for 300 seconds.
9/ Record the new temperature of the water.
10/ Calculate the energy released by the circuit from:
Heat Energy (Joules) = Temperature Change X Water Volume (ml) X 4.180 (Heat Cap.)
11/ Calculate the power output from:
Power (Watts) = Energy / Time (seconds)

Record	Figure
Water Vol.	
First temp.	
Final Temp.	
Energy	
Power	



Result: The water temperature rose by about 10 degrees.

Conclusion: The Power Output of the circuit is about 15Watts, the electrical energy being converted into heat energy.

Risk Level: Low Hazard: Beware of students using high voltage settings since this will cause the circuit breakers in the power supplies to trip. Caution students not to turn on the power unless the wire is immersed otherwise burnt fingers and marked benches will result.

STUDENT:____________________

252 Competing Equilibria

Aim: To demonstrate that a series of reactions can take place involving the same anion.

Equipment

Test Tube, large
Silver nitrate, 0.1M,(1.7%0
Dropper Bottles:
Ammonia, 0.1M, (0.7%)
Sodium chloride,0.1M (0.6%)
Sodium Bromide,0.1M,1%
Sodium Thiosulfate, 0.1M, (1.6%)
Sodium Iodide, 1M, (1.5%)

Procedure

1/ Add 1cm of silver nitrate solution to the test tube.
2/ Mix sodium chloride dropwise until a change occurs.
3/ Mix ammonia solution dropwise until a change occurs.
4/ Mix sodium bromide dropwise until a change occurs.
5/ Mix sodium thiosulfate dropwise until a change occurs.
6/ Mix sodium iodide dropwise until a change occurs.

- How can a precipitate be forced to dissolve? (Think in terms of reversible reactions)
- Write an equation for each reaction (Thiosulfate = $S_2O_3^{2-}$)
- What can you conclude about the equilibrium constant of the reactions?

Reagent	Result / Equation
Chloride	
Ammonia	
Bromide	
Thiosulfate	
Iodide	

Results: ____________________

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Conclusion: ____________________

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252

Competing Equilibria

Topics: Equilibrium Chem Reactions

Aim: To demonstrate that a series of reactions can take place involving the same anion.

Equipment

Test Tube, large
Silver nitrate, 0.1M,(1.7%0
Dropper Bottles:
Ammonia, 0.1M, (0.7%)
Sodium chloride,0.1M (0.6%)
Sodium Bromide,0.1M,1%
Sodium Thiosulfate, 0.1M, (1.6%)
Sodium Iodide, 1M, (1.5%)

Procedure

1/ Add 1cm of silver nitrate solution to the test tube.
2/ Mix sodium chloride drop wise until a change occurs.
3/ Mix ammonia solution drop wise until a change occurs.
4/ Mix sodium bromide drop wise until a change occurs.
5/ Mix sodium thiosulfate drop wise until a change occurs.
6/ Mix sodium iodide drop wise until a change occurs.

- Write an equation for each reaction (Thiosulfate = $S_2O_3^{2-}$)
- What can you conclude about the equilibrium constant of the reactions?

$Ag^+ + Cl^- <> AgCl$

$Ag^+ + 2NH_3 <> Ag(NH3)2+$

$Ag^+ + Br^- <> AgBr$

$Ag^+ + 2S_2O_3^{2-} <> Ag(S_2O_3)_2^{3-}$

$Ag^+ + I^- <> AgI$

Result: A white precipitate forms with the chloride but dissolves with ammonia. A yellow precipitate forms with the bromide but dissolves with the thiosulfate. A bright yellow precipitate forms with the iodide.

Conclusion: In case a reaction occurs with a higher numerical equilibrium constant. The precipitates dissociate because their formation reaction is forced to reverse as the silver ions are consumed in a new reaction.

Risk Level: Moderate Hazard: Concentrated or solid silver nitrate is corrosive to skin and eyes, harmful by ingestion and stains skin. Contact is to be avoided with the other silver products in this experiment. The sodium reagents in the experiment pose minimal hazard in these concentrations.

STUDENT:________________

253 Equilibrium & Heat

Aim: To confirm that temperature effects the direction of a reaction.

Equipment

Cobalt Chloride
Hydrochloric Acid 1M(10%)
Test Tube (20ml)
Beakers, 250ml, two
Test tube peg
Ice
Hot water
Measuring Cylinder, 10ml
Filter paper

Procedure

1/ Weigh 0.1g cobalt chloride on a filter paper.
2/ Add the cobalt chloride to a test tube and dissolve with 5mls of water. Note the colour of the solution.
3/ Add 5ml of 1M hydrochloric acid.
4/ Note the colour of the solution.
5/ Add Ice water to a beaker. Place the test tube in the ice water and note any colour change after five minutes.
6/ Place hot water in a second beaker. Place the test tube in this beaker and note any colour change after 5 minutes.

The reaction taking place is as follows:

$Co(H_2O)_6^{2+} + 4Cl^- \rightleftharpoons CoCl_4^{2-} + 6H_2O$

- Which cobalt ion is responsible for red colour?
- Which cobalt ion is responsible for blue colour?
- Explain why only one of these ions predominates at a certain temperature.
- Explain any other colours observed.

Results: ____

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Conclusion: ____

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253

Equilibrium & Heat

Topics: Equilibrium Chem Reactions

Aim: To confirm that temperature effects the direction of a reaction.

Equipment

Cobalt Chloride
Hydrochloric Acid 1M(10%)
Test Tube (20ml)
Beakers, 250ml, two
Test tube peg
Ice
Hot water
Measuring Cylinder, 10ml
Filter paper

Procedure

1/ Weigh 0.1g cobalt chloride on a filter paper.
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4/ Note the colour of the solution.
5/ Add Ice water to a beaker. Place the test tube in the ice water and note any colour change after five minutes.
6/ Place hot water in a second beaker. Place the test tube in this beaker and note any colour change after 5 minutes.

The reaction taking place is as follows:

$Co(H_2O)_6^{2+} + 4Cl^- <> CoCl_4^{2-} + 6H_2O$

- Which cobalt ion is responsible for red colour?
- Which cobalt ion is responsible for blue colour?
- Explain why only one of these ions predominates at a certain temperature.
- Explain any other colours observed.

Result: The original solution is pale red. Adding acid produces a violet colour. Cooling the reaction produces a red colour while heating results in a blue colour.

Conclusion: $Co(H_2O)_6^{2+}$ is a red ion produced by dissolving the cobalt chloride.

$CoCl_4^{2-}$ is a blue ion which predominates when the reaction with hydrochloric acid is pushed to the right by heating. Cooling forces the equilibrium back to the left. Violet is a mixed equilibrium at room temperature.

Risk Level: Moderate Hazard: Cobalt chloride is toxic if ingested and may be carcinogenic. Hydrochloric acid is corrosive and contact with the skin should be treated with prolonged washing

STUDENT:____________________

254

Paper Planes

Aim: To design and build a paper plane with the longest straight flight.

Equipment

Paper (used)
Designs (eg. Best Ever Paper Planes by Paul Jackson, ISBN 1-85479-334-9)

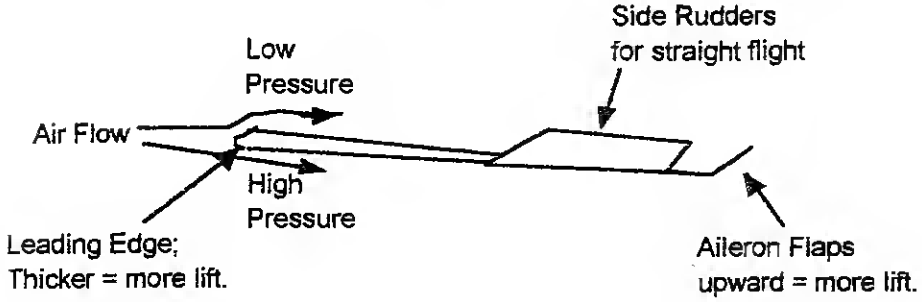
Procedure

1/ Fold three paper planes of different design.
2/ Test your planes in the school hall.
3/ Using the hints below modify the design that flew best.
4/ Test fly your design and make adjustments again.

The process above is a design procedure that mimics evolution. Firstly a random set of designs a chosen. A test is performed to select the best design. The test is similar to selection pressure in the wild ensuring only the fittest survive. Next changes are made to the selected design. These changes are similar to mutation and cross breeding in nature. The modified designs are tested and again the best are selected for further changes. In nature, success is passing your genes to your offspring.

Record the features of the best design.

Wing Shape



Results: ____

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Conclusion: ____

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254

Paper Planes

Topics: Flight Evolution

Aim: To design and build a paper plane with the longest straight flight.

Equipment

Paper (used)
Designs (eg. Best Ever Paper Planes by Paul Jackson, ISBN 1-85479-334-9)

Procedure

1/ Fold three paper planes of different design.
2/ Test your planes in the school hall.
3/ Using the hints below modify the design that flew best.
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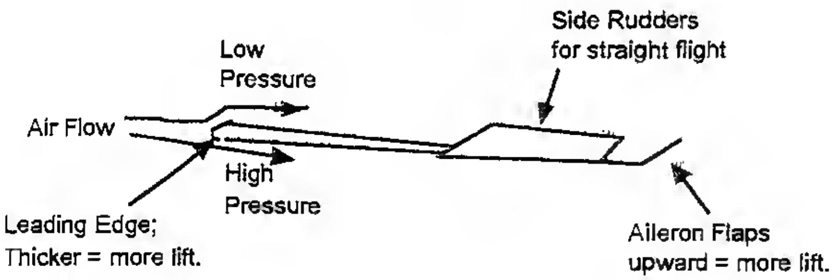
The process above is a design procedure that mimics evolution. Firstly a random set of designs a chosen. A test is performed to select the best design. The test is similar to selection pressure in the wild ensuring only the fittest survive. Next changes are made to the selected design. These changes are similar to mutation and cross breeding in nature. The modified designs are tested and again the best are selected for further changes. In nature, success is passing your genes to your offspring.

A sweet reward will add incentive and help self regulate the competition.

Record the features of the best design.

Wing Shape



Result:

Conclusion: Rudders and balanced lift (nose to tail and across both wings) will be evident in the best design. Darts fall too fast to achieve great distance.

Risk Level: Low Hazard: Great Fun

STUDENT:________________

255

Streamlining

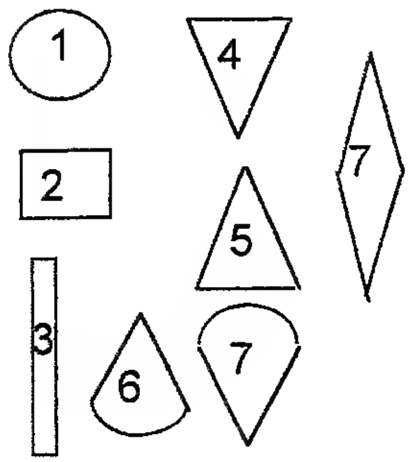
Aim: To investigate the effect of streamlining the shape of an object moving through a liquid or gas.

Equipment

Plasticine
Screw, 20mmX 8G
Measuring cylinder, 100ml
Stop watch
Chalk

Procedure

1/ Role 3cm of plasticine into a ball.
2/ Insert the screw to give one end added weight.
3/ Scrape a little chalk dust into the measuring cylinder.
4/ Fill the measuring cylinder with water.
5/ Drop the ball into the water (weighted end down) and use the stop watch to measure the time for the ball to reach the bottom of the cylinder.
6/ Repeat the test observing the water flow around the object by watching the behaviour of the suspended chalk dust.
7/ Change the shape of the plasticine and repeat the test.
8/ Repeat until all the shapes below have been tested.



Shape	Time (secs)
ball	
cube	
cylinder	
cone	
cone (inv)	
Tear	
Tear (inv)	
2X Cone	

Results: ____

____

____

Conclusion: ____

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255

Streamlining

Topics: Flight Density & Pressure

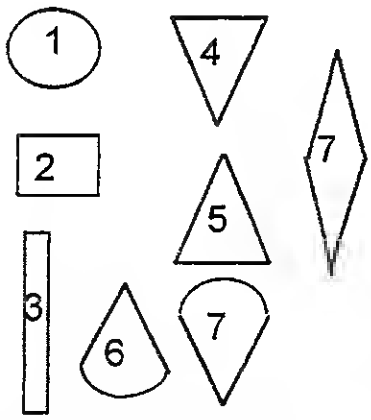
Aim: To investigate the effect of streamlining the shape of an object moving through a liquid or gas.

Equipment

Plasticine
Screw, 20mmX 8G
Measuring cylinder, 100ml
Stop watch
Chalk

Procedure

1/ Role 3cm of plasticine into a ball.
2/ Insert the screw to give one end added weight.
3/ Scrape a little chalk dust into the measuring cylinder.
4/ Fill the measuring cylinder with water.
5/ Drop the ball into the water (weighted end down) and use the stop watch to measure the time for the ball to reach the bottom of the cylinder.
6/ Repeat the test observing the water flow around the object by watching the behaviour of the suspended chalk dust.
7/ Change the shape of the plasticine and repeat the test.
8/ Repeat until all the shapes below have been tested.



Shape	Time (secs)
ball	
cube	
cylinder	
cone	
cone (inv)	
Tear	
Tear (inv)	
2X Cone	

Result: The double cone moved through the water fastest, the cube moving slowest. The water was observed to move rapidly around broad surfaces and to swirl behind objects without a pointed trailing end.

Conclusion: Objects pointed at the leading edge part the liquid easily and allow a smooth flow over the surface. Objects pointed at the trailing end minimise swirling turbulence. Objects pointed at both ends are streamlined, that is, shaped to allow smooth flow of the liquid or gas over the surfaces and minimising turbulence.

Risk Level: Low hazard: Surprisingly popular, perhaps because it provides an excuse for older students to play with plasticine.

STUDENT:________________

256 Angular Momentum

Aim: To observe angular momentum in action and its implications for the Earth spinning on its axis.

Equipment

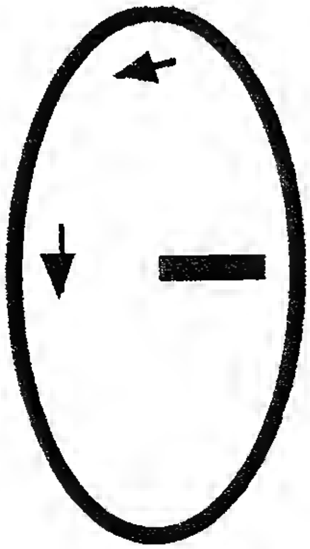
Bicycle wheel
stunt pegs, two
Gyroscope

Procedure

A spining object has a gyroscopic property in that it resists any torque applied to its axis, producing a resultant force which is at 90 degrees to the axis and the applied torque.

1/ Hold the bicycle wheel in front of your body by gripping the stunt pegs on either side.
2/ An assistant spins the wheel rapidly.
3/ Try turning your body to to the left or right.
4/ Try tilting the wheel.
5/ Start a gyroscope, virtically on the table and observe its behaviour.

- If the gyroscope were the Earth, what would be happening to the tilt of its axis?
- Explain the movement of the gyroscope in terms of your observation with the bicyle wheel.
- What happens to the lean of a bike if you turn to the left?
- Could a bike be steered simply by tilting the frame?



Results: ____

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Conclusion: ____

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256

Angular Momentum

Topics: Forces Earth & Space

Aim: To observe angular momentum in action and its implications for the Earth spinning on its axis.

Equipment

Bicycle wheel
stunt pegs, two
Gyroscope

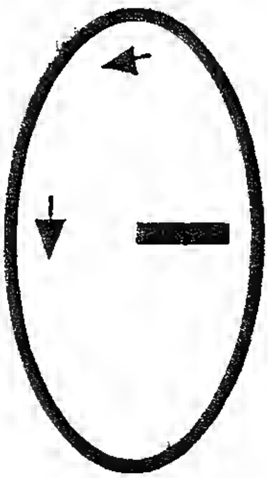
Procedure

A spinning object has a gyroscopic property in that it resists any torque applied to its axis, producing a resultant force which is at 90 degrees to the axis and the applied torque.

1/ Hold the bicycle wheel in front of your body by gripping the stunt pegs on either side.
2/ An assistant spins the wheel rapidly.
3/ Try turning your body to to the left or right.
4/ Try tilting the wheel.
5/ Start a gyroscope, vertically on the table and observe its behaviour.

- If the gyroscope were the Earth, what would be happening to the tilt of its axis?
- Explain the movement of the gyroscope in terms of your observation with the bicycle wheel.
- What happens to the lean of a bike if you turn to the left?
- Could a bike be steered simple by tilting the frame?

The axis of the Earth precesses once every 10,000 years and this is thought to cause cyclic ice ages.



Result: Turning to the left results in the wheel tilting to the left. Tilting the wheel to the left results in the axis of the wheel turning to the left.

Conclusion: Since the Earth is much like a gyroscope and undergoes a torque from the gravitational pull of the sun, the axis of the Earth wobbles (precesses). The gyroscope wobbles in a circle because of the gravitational pull of the Earth. A bike turning left, tilts to the left and can actually be steered by just tilting the frame.

Risk Level: Low Hazard: Tremendous fun. The students really are intrigued. These forces are not actually noticed when the bicycle wheel is fixed in a frame. Have you noticed that car races are always in a clockwise circuit? This is because the torque on the rotating crankshaft will force the front wheels onto the ground. A clockwise circuit would reduce grip in the steering unless the engine rotation were changed. East/west engines suffer a flip torque.

STUDENT:________________

257

Force Fields

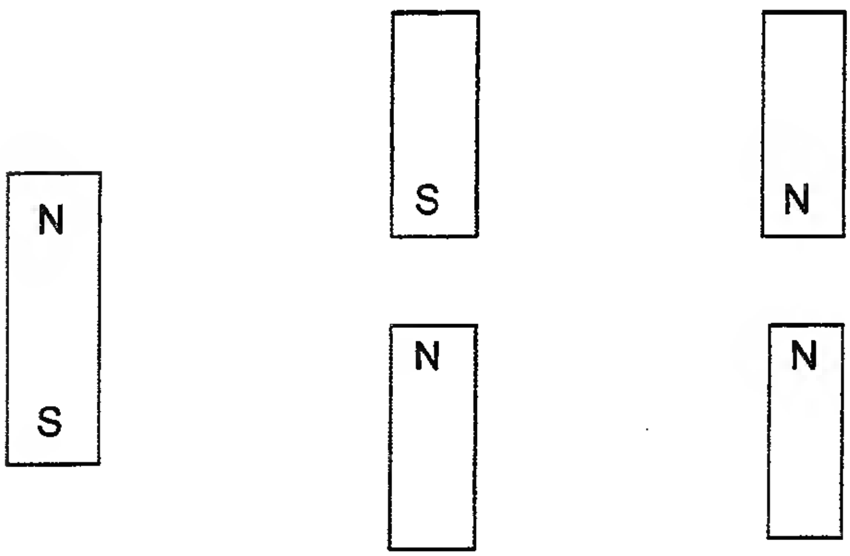
Aim: To reveal invisible lines of magnetic force.

Equipment

Bar Magnets, two
Iron filings
Paper, A4 sheet
Specimen tube, small

Procedure

1/ Pace two spatulas of iron filitings in the specimen tube.
2/ Place the sheet of paper over a bar magnet on the bench.
3/ Using the specimen tube like a salt shaker, sprinkle iron filings on the paper until a pattem forms.
4/ Draw the pattem in the space below.
5/ Lift the paper to form a U-shaped trough and pour the filings back into the specimen tube.
6/ Place two magnets on the bench so that the South pole of one is about 2cm from the North pole of the second magnet.
7/ Lay the sheet of paper over the magnets and sprinkle filings until a pattem forms.
8/ Draw the pattem in the space below.
9/ Lift the paper and retum the filings to the specimen tube.
10/ Place two magnets on the bench so that the North pole of one is about 2cm from the North pole of the other magnet.
11/ Lay paper over the magnets and sprinkle iron filings until a pattem forms.
12/ Draw the pattem in space below.



Results: ________________________________

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Conclusion: ________________________________

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257

Force Fields

Topics: Forces

Aim: To reveal invisible lines of magnetic force.

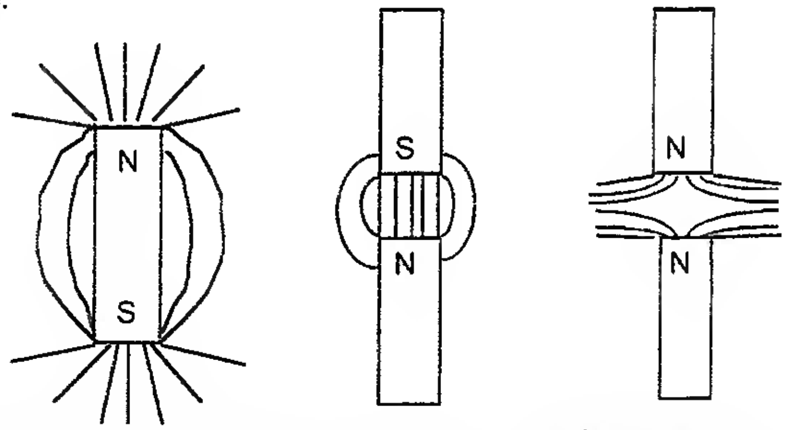
Equipment

Bar Magnets, two
Iron filings
Paper, A4 sheet
Specimen tube, small

Prepare the specimen tube by making a central hole through the inner surface of the plastic cap with a hot dissecting needle.

Procedure

1/ Pace two spatulas of iron filings in the specimen tube.
2/ Place the sheet of paper over a bar magnet on the bench.
3/ Using the specimen tube like a salt shaker, sprinkle iron filings on the paper until a pattern forms.
4/ Draw the pattern in the space below.
5/ Lift the paper to form a U-shaped trough and pour the filings back into the specimen tube.
6/ Place two magnets on the bench so that the South pole of one is about 2cm from the North pole of the second magnet.
7/ Lay the sheet of paper over the magnets and sprinkle filings until a pattern forms.
8/ Draw the pattern in the space below.
9/ Lift the paper and return the filings to the specimen tube.
10/ Place two magnets on the bench so that the North pole of one is about 2cm from the North pole of the other magnet.
11/ Lay paper over the magnets and sprinkle iron filings until a pattern forms.
12/ Draw the pattern in space below.



Result: Lines of force radiate from each pole of a magnet. Lines of force link and arch around the space between a North and South pole. Lines of force clash and spread perpendicularly between two North magnetic poles.

Conclusion: Lines of force from magnetic poles have a direction. Between opposite poles the lines run into each other. Between similar poles the lines repel each other and are forced to the sides.

Risk Level: Low Hazard.

STUDENT:____________________

258

Magnetism

Aim: To investigate magnetic force.

Equipment

Bar Magnets, two
Magnetic compass
Iron Nails, 20mm, 3
Alfoil, 5cmX5cm
Copper strip

Procedure

1/ Investigate what materials are attracted to a magnet. Try wood, plastic, iron, copper, aluminium etc.
-Does it matter which end of the magnet you use?
2/ Investigate how a compass needle reacts to the North pole of a magnet.
3/ Investigate how a compass needle reacts to the South pole of a magnet.
4/ Investigate how the South pole of one magnet reacts when the South pole of another magnet is brought near.
5/ Investigate how the South pole of one magnet reacts when the North pole of another magnet is brought near.
6/ Investigate how the North pole of one magnet reacts when the North pole of another magnet is brought near.
- Write two simple rules which descibe how magnetic poles react when they approach each other.
- Is a compass simply a piece of iron?
- Why do you think the poles of a magnet are named North and South?
- What is at the North Pole of the Earth to attract a compass?

Results: ____

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Conclusion: ____

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258

Magnetism

Topics: Forces

Aim: To investigate magnetic force.

Equipment

Bar Magnets, two
Magnetic compass
Iron Nails, 20mm, 3
Alfoil, 5cmX5cm
Copper strip

Procedure

1/ Investigate what materials are attracted to a magnet. Try wood, plastic, iron, copper, aluminium etc.
-Does it matter which end of the magnet you use?
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- Write two simple rules which describe how magnetic poles react when they approach each other.
- Is a compass simply a piece of iron?
- Why do you think the poles of a magnet are named North and South?
- What is at the North Pole of the Earth to attract a compass?

Result: Iron objects are attracted both ends of a magnet. Compass needles are repelled by North poles but attracted by South poles. South poles repel each other but attract North poles. North poles repel each other.

Conclusion: LIKE POLES REPEL. OPPOSITE POLES ATTRACT. A compass is a small magnet. The North pole of a compass or magnet will point to the North Pole of the Earth. The North Pole of the Earth must have a South magnetic pole.

Risk Level: Low Hazard

STUDENT:________________________

259 Tension & Acceleration

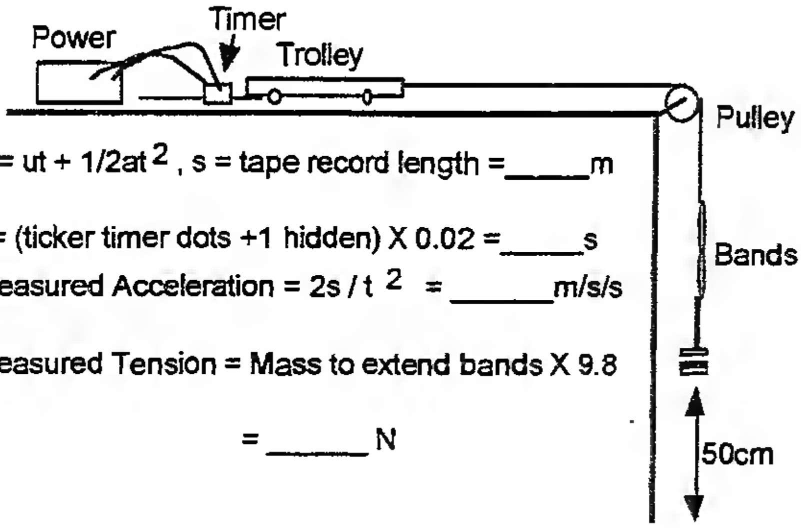
Aim: To experimentally determine the acceleration and tension in a system in motion.

Equipment

Collision trolley
Bench pulley
String, 80cm
Mass Carrier
Masses, 50g(4),25g,5g (4)
Ticker Timer
Paper Tape
Power supply, 0-12V, AC
Connecting wires, two
Rubber bands, two
Adhesive tape
Metre rule.

Procedure

1/ Adjust the trolley mass to 600g by adding masses.
2/ Tie one end of the string to the trolley. Tie the rubber bands together and tie to the other end of the string.
3/ Attach 60cm of paper tape to the rear of the trolley with adhesive tape. Pass the paper tape through the ticker timer.
4/ Set the power supply to 6V and connect the ticker timer to the AC terminals.
5/ Place two 50g masses on the mass carrier and hook the carrier onto the end rubber band.
6/ Move the tolley and ticker timer until the mass carrier is 50cm above the floor.
7/ Simultaneously release the trolley and turn on the power, switching the power off as the mass carrier strikes the floor.
8/ Measure the length of the ticker timer record. _____
9/ Deducting the fall height will give the change in extension of the rubber bands.
10/ Suspend the mass carrier and replace wieghts until the change in extesion is duplicated. Mass = ________
11/ Count the dots on the timer timer record._______



$s = ut + 1/2at^2$, s = tape record length =_____m

t = (ticker timer dots +1 hidden) X 0.02 =_____s

Measured Acceleration = $2s / t^2$ = ______m/s/s

Measured Tension = Mass to extend bands X 9.8

= ______N

Results: ____

____

____

Conclusion: ____

____

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259

Tension & Acceleration

Topics: Forces

Aim: To experimentally determine the acceleration and tension in a system in motion.

Equipment

Collision trolley
Bench pulley
String, 80cm
Mass Carrier
Masses, 50g(4),25g,5g (4)
Ticker Timer
Paper Tape
Power supply, 0-12V, AC
Connecting wires, two
Rubber bands, two
Adhesive tape
Metre rule.

Procedure

1/ Adjust the trolley mass to 600g by adding masses.
2/ Tie one end of the string to the trolley. Tie the rubber bands together and tie to the other end of the string.
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6/ Move the trolley and ticker timer until the mass carrier is 50cm above the floor.
7/ Simultaneously release the trolley and turn on the power, switching the power off as the mass carrier strikes the floor.
8/ Measure the length of the ticker timer record. _____
9/ Deducting the fall height will give the change in extension of the rubber bands.
10/ Suspend the mass carrier and replace weights until the change in extension is duplicated. Mass = ________
11/ Count the dots on the timer timer record._______

Theoretical

Net accelerating force = mass X gravity
= 0.15kg X 9.8 = 1.03N
Acceleration = Force / total mass
= 1.013 / (0.6 + 0.15) = 1.35m/s/s
Tension = Trolley mass X acceleration
=0.6 X 1.35 = 0.81N

Result: The ticker timer recorded the acceleration of the trolley and the change in extension of the rubber bands. The extension of the rubber bands is a measure of tension in the string.

Conclusion: Friction will ensure that the measured acceleration will be less than the than the theoretical value. While this would imply a reduced tension value from the theory calculation, friction actually increases the tension required to achieve the reduced acceleration. As a result the measured tension will be close to the theoretical value.

Risk Level: Low Hazard:

STUDENT:____________________

260 Pressure Ignition

Aim: To demonstrate that if the pressure applied to a given volume of gas is sharply increased, the temperature will rise even to ignition point.

Equipment

"Pressure Ignition" apparatus.
Cotton wool
Alcohol
Vacuum grease

Procedure

1/ Insure the plunger is greased and pliable.
2/ Moisten a small wad of cotton wool with alcohol.
3/ Squeeze out the excess alcohol.
4/ Insert the cotton wool into the base of the cylinder.
5/ Position the plunger.
6/ Ram the plunger toward the base.

This principle is used in Diesel Engines where the compression by the piston provides ignition instead of a spark plug.

Results: ____

____

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Conclusion: ____

____

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260

Pressure Ignition

Topics: Gas Laws Density/Pressure

Aim: To demonstrate that if the pressure applied to a given volume of gas is sharply increased, the temperature will rise even to ignition point.

Equipment

"Pressure Ignition" apparatus.
Cotton wool
Alcohol
Vacuum grease

Procedure

1/ Insure the plunger is greased and pliable.
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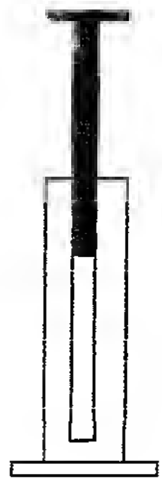
This principle is used in Diesel Engines where the compression by the piston provides ignition instead of a spark plug.



Result: The cotton wool ignites

Conclusion: As pressure increases sharply for a given volume, temperature increases.

$$PV = kT$$

Risk Level: Low Hazard: However the apparatus will not last long in the hands of students. Teacher demonstration only.

STUDENT:____________________

261 Genetic Differences

Aim: To investigate dominant and recessive genes in humans.

Equipment

Procedure

Dominant genes are expressed even if only one chromosome in a pair carries the gene. Recessive genes are only expressed if both chromosomes in a pair to carry the gene. In a multicultural society such as Australia, dominant genes will be much more common than recessive genes.

Survey the class for the characteristics listed in the table below, recording how many students have those characteristics.

From the results try to conclude which genes are likely to be dominant and which are likely to be recessive.

Trait	Number	Trait	Number
Brown Eyes		Black/Brown hair	
Blue eyes		Fair hair	
Hasel eyes		Red Hair	
Darwins Ear Point		Peaked Hair line	
No Ear Point		Smooth Hair Line	
Tongue Rolling		No Tongue Rolling	

Results: ____________________

____

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Conclusion: ____________________

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261

Genetic Differences

Topics: Genetics

Aim: To investigate dominant and recessive genes in humans.

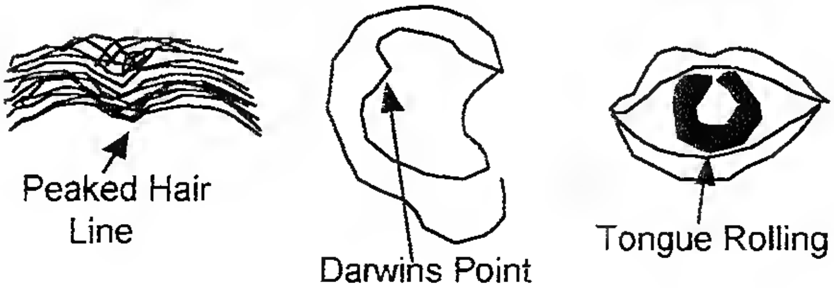
Equipment

Procedure

Dominant genes are expressed even if only one chromosome in a pair carries the gene. Recessive genes are only expressed if both chromosomes in a pair to carry the gene. In a multicultural society such as Australia, dominant genes will be much more common than recessive genes.

Survey the class for the characteristics listed in the table below, recording how many students have those characteristics.

From the results try to conclude which genes are likely to be dominant and which are likely to be recessive.



Result: Black/ Brown hair, brown eyes, Darwins Point, tongue rolling and peaked hair line are all common traits. Red hair, blue eyes, no ear point, no tongue rolling and smooth hair line are much less common.

Conclusion: Black/ Brown hair, brown eyes, Darwins Point, tongue rolling and peaked hair line are all due to dominant genes. Red hair, blue eyes, no ear point, no tongue rolling and smooth hair line are due to recessive genes. Fair hair and Hazel eyes are dominant genes which share expression with other colour genes.

Risk Level: Low Hazard: Be careful about making statements like " parents with blue eyes will not have brown eyed offspring". Few human traits are governed by a single gene locus and so simple Mendelian rules do not apply. You do not want to have a student doubting their parents.

STUDENT:____________________

Zeibops

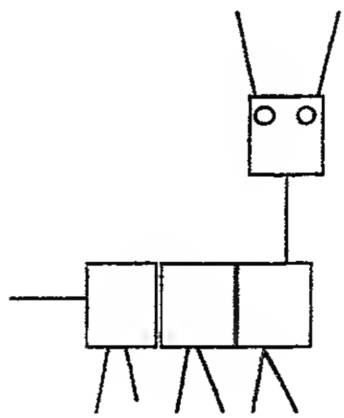
Aim: To investigate genetic recombination through generations of the imaginary animals, Zeibops.

Equipment

Coloured Pop sticks
(chromosome pairs) :
Two,red,10cm,"A" and "a"
Two,red, 8.5cm, "T" and "t"
Two,red, 7cm, "Q" and "q"
Two,red,5.5cm, "D" and "d"
Two,red,4cm, "E" and "e"
Two,red,2.5cm, "G" and "g"
Repeat set in green
Marsh mellows, four
Match sticks, eight
Drawing pins, three

Procedure

1/ Take the red male chromosomes and randomly take one from each pair (meiosis producing sperm).
2/ Take the green female chromosomes and randomly take one from each pair (meiosis producing ova).
3/ Match the remaining red chromosomes with the remaining green chromosomes (fertilisation).
4/ Construct the progeny according to:
AA or Aa - three body segments - marsh mellows
aa - two body segments
TT or Tt - six legs (match sticks), tt - 4 legs
QQ - long neck (match sticks), Qq short neck, qq - no neck
Head is a marsh mellow.
DD - 2 antennae (match sticks),Dd 1 antennae, dd - none
EE or Ee - tail (match stick), ee - no tail
GG or Gg - two eyes (drawing pins), gg - three eyes
5/ Copy the table of class results drawn up by the teacher.



A parent Zeibop

Results: ____

____

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Conclusion: ____

____

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262

Zeibops

Topics: Genetics

Aim: To investigate genetic recombination through generations of the imaginary animals, Zeibops.

Equipment

Coloured Pop sticks (chromosome pairs) :
Two,red,10cm,"A" and "a"
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Two,red, 7cm, "Q" and "q"
Two,red,5.5cm, "D" and "d"
Two,red,4cm, "E" and "e"
Two,red,2.5cm, "G" and "g"
Repeat set in green
Marsh mellows, four
Match sticks, eight
Drawing pins, three

Procedure

1/ Take the red male chromosomes and randomly take one from each pair (meiosis producing sperm).
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QQ - long neck (match sticks), Qq short neck, qq - no neck
Head is a marsh mellow.
DD - 2 antennae (match sticks),Dd 1 antennae, dd - none
EE or Ee - tail (match stick), ee - no tail
GG or Gg - two eyes (drawing pins), gg - three eyes
5/ Copy the table of class results drawn up by the teacher.

Phenotype	Number	%	Genotype	Number	%
3 segments			AA		
			Aa		
2 segments			aa		
6 legs			TT		
			Tt		
4 legs			tt		
Long Neck			QQ		
Short Neck			Qq		
No Neck			qq		

Result: Dominant phenotypes occur in 75% of offspring while the recessive phenotype occurs in 25% of offspring but the genotypes are 25% pure dominant, 50% hybrid dominant and 25% pure recessive.

Conclusion: Meiosis halves the chromosome pairs randomly producing a variety of characteristics in the offspring when the chromosome pairs are reformed in fertilisation.

Risk Level: Low Hazard: promise to give them clean marsh mellows to eat at the end of the practical.

STUDENT:________________

263

Antisepsis

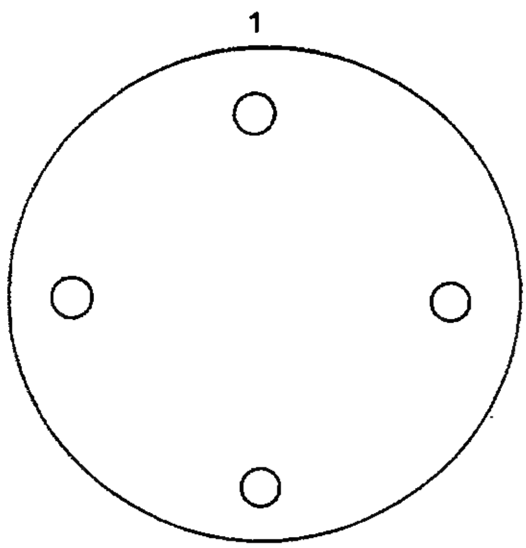
Aim: To compare various substances designed to kill microbes.

Equipment

Petri Dish
Culture Solution : (1 beef stock cube, 10g Agar Agar per 500ml water, heated to boiling).
Cork borer
Marker pen
Paper tissues
Forceps
Filtered rise water from a garbage bin.
Dropper Bottles of:
Sodium Chloride 3%
Bleach (10% dilution)
Phenol Antiseptic(10% dil.)
Ethanol (10% dilution)

Procedure

1/ Pour hot culture solution into the petri dish and allow to gel (about ten minutes).
2/Rinse the surface of the culture gel with some of the garbage bin rinse.
3/ Use the cork borer tool to make four holes in the gel as shown below.
4/ Mark the outside edge of the petri dish adjacent to one hole, now hole number 1, progressing 2, 3, 4, clockwise.
5/ Fill hole 1 with sodium chloride solution.
6/ Fill hole number 2 with diluted bleach.
7/ Fill hole number 3 with diluted antiseptic.
8/ Fill hole number 4 with diluted ethanol.
9/ Place the cover on the petri dish and leave in a warm, dark place for 48 hours.
10/ IN THE FUME HOOD - The peri dish lid is probably opaque due to internal condensation.Remove the lid and mop up the condensation with a tissue held with forceps. Replace the lid and inspect the culture at your work bench.
11/ Draw the appearance of the culture plate on the diagram below.



Results: ____

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Conclusion: ____

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263

Antisepsis

Topics: Inside Life

Aim: To compare various substances designed to kill microbes.

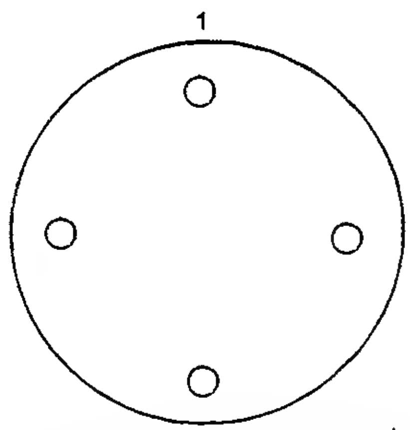
Equipment

Petri Dish
Culture Solution : (1 beef stock cube, 10g Agar Agar per 500ml water, heated to boiling).
Cork borer
Marker pen
Paper tissues
Forceps
Filtered rise water from a garbage bin.
Dropper Bottles of:
Sodium Chloride 3%
Bleach (10% dilution)
Phenol Antiseptic(10% dil.)
Ethanol (10% dilution)

Waste bucket in fume hood

Procedure

1/ Pour hot culture solution into the petri dish and allow to gel (about ten minutes).
2/Rinse the surface of the culture gel with some of the garbage bin rinse.
3/ Use the cork borer tool to make four holes in the gel as shown below.
4/ Mark the outside edge of the petri dish adjacent to one hole, now hole number 1, progressing 2, 3, 4, clockwise.
5/ Fill hole 1 with sodium chloride solution.
6/ Fill hole number 2 with diluted bleach.
7/ Fill hole number 3 with diluted antiseptic.
8/ Fill hole number 4 with diluted ethanol.
9/ Place the cover on the petri dish and leave in a warm, dark place for 48 hours.
10/ IN THE FUME HOOD -Remove the lid and mop up any condensation with a tissue held with forceps. Replace the lid and inspect the culture at your work bench.
11/ Draw the appearance of the culture plate on the diagram below.



Result: Bacteria and fungi grew prolifically over the plate but left clear rings around holes 2,3, and 4. Some grow was evident close to hole 1.

Conclusion: Bleach, phenol antiseptic and ethanol were all effective at preventing microbe growth. Salty water was partially effective at preventing microbe growth.

Risk Level: Moderate Hazard: Biohazard risk. All cultures should be treated as a potential source of pathogens. Tissue wipes and the cultures should be collected in a bucket in the fume hood before being sealed in a garbage bag for disposal. Students should be warned not to open the cultures except in the fume hood. All students should wash their hands before leaving the room.

STUDENT:________________

264

Enzymes 1

Aim: To examine the temperature dependence of the catalytic action of an enzyme.

Equipment

Rennin tablets
Stirring rod
Beakers, 250ml, four
Dropper bottle
Test tubes, medium, four
Hot water
Thermometer
Glass stirring rod

Procedure

Rennin (chymase) is an enzyme secreted in the stomach of young animals to aid the digestion of milk. Rennin converts milk from a liquid into a gel.

1/ Prepare four beakers, one containing ice water, one containing tap water adjusted to 20 ^{O}C, one containing tepid water at 35 ^{O}C and one containing hot water at 50 ^{O}C.

2/ Place a medium test tube containing 5mls of milk into each beaker and allow 2 minutes for the milk to reach temperature.

3/ Dissolve one rennin tablet in 20mls of water in a dropper bottle then add 10 drops to each test tube, stirring briefly.

4/ Record the time taken in each beaker for a clear layer to begin to develop at the base of the milk.

Temperature	Time
4 degrees C	
20 Degrees C	
35 degrees C	
50 degrees C	

Results: ____

____

____

Conclusion: ____

____

____

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264

Enzymes 1

Topics: Inside Life Biological Chem

Aim: To examine the temperature dependence of the catalytic action of an enzyme.

Equipment

Rennin tablets
Stirring rod
Beakers, 250ml, four
Dropper bottle
Test tubes, medium, four
Hot water
Thermometer
Glass strirring rod

The teacher must decide when to cease the experiment. Tepid milk will gel in 10minutes, iced milk may take an hour.

Procedure

Rennin (chymase) is an enzyme secreted in the stomach of young animals to aid the digestion of milk. Rennin converts milk from a liquid into a gel.

1/ Prepare four beakers, one containing ice water, one containing tap water adjusted to 20 ^{o}C, one containing tepid water at 35 ^{o}C and one containing hot water at 50 ^{o}C.

2/ Place a medium test tube containing 5mls of milk into each beaker and allow 2 minutes for the milk to reach temperature.

3/ Dissolve one rennin tablet in 20mls of water in a dropper bottle then add 10 drops to each test tube, stirring briefly.

4/ Every minute, check the milk in each tube by touching a glass stirring rod to the surface. If a droplet of milk adheres, the milk is still liquid.

5/ Record the time taken in each beaker for the milk to gel.

Result: The rennin acts fastest at 35 degrees, slower at 20 degrees and much slower in ice or hot water.

Conclusion: Rennin is a biological catalyst which works best close to normal body temperatures.

Risk Level: Low Hazard

STUDENT:________________

265 # Enzymes 2

Aim: To examine the effect of denaturation on an enzyme.

Equipment

Thermometer
Rennin tablets
Dropper bottle
Beakers, 250ml, two
Test tubes, medium, four
Tripod
Bunsen
Milk
Measuring cylinder, 10ml
Marking pen
Hot water
Dropper Bottles:
Hydrochloric acid, 1M, 10%
Sodium Hydroxide, 1M, 4%
Glass stirring rod

Procedure

three dimensional structure of enzymes (or any protein) can be permanently altered.
1/ Heat 50mls of water in a beaker to 60 degrees centigrade.
2/ Dissolve a rennin tablet in 20ml of water in a dropper bottle and add 5 drops to each of four test tubes.
3/ Add 10 drops of water to two of the tubes and markr these tubes as 1 and 2.
4/ Place tube number 2 in the beaker of hot water.
5/ Take another tube of rennin, mark it as 3 and add 5 drops of hydrochloric acid.
6/ Mark the last tube of rennin as 4 and add 5 drops of sodium hydroxide.
7/ After 2 minutes, nuetralise the acid in tube 3 by adding 5 drops of sodium hydroxide and nuetralise the base in tube 4 by adding 5 drops of acid.
8/ Place all four tubes in a beaker containing 100mls of tepid water(about 35 degrees), add 5mls of milk to each and record the time needed for a clear layer to develop.

Tube	Treatment	Time
1	None	
2	2 mins 60 degrees C	
3	2 mins Acid	
4	2 mins Base	

Results: ____

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Conclusion: ____

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265

Enzymes 2

Topics: Inside Life Biological Chem

Aim: To examine the effect of denaturation on an enzyme.

Equipment

Thermometer
Rennin tablets
Dropper bottle
Beakers, 250ml, two
Test tubes, medium, four
Tripod
Bunsen
Milk
Measuring cylinder, 10ml
Marking pen
Hot water
Dropper Bottles:
Hydrochloric acid, 1M, 10%
Sodium Hydroxide, 1M, 4%
Glass stirring rod

Teacher will ahve to decide when to cease the experiment.

Procedure

Denaturation: Under extremes of temperature and pH, the three dimensional structure of enzymes (or any protein) can be permanently altered.

1/ Heat 50mls of water in a beaker to 60 degrees centigrade.
2/ Dissolve a rennin tablet in 20ml of water in a dropper bottle and add 10 drops to each of four test tubes.
3/ Add 10 drops of water to two of the tubes and mark these tubes as 1 and 2.
4/ Place tube number 2 in the beaker of hot water.
5/ Take another tube of rennin, mark it as 3 and add 5 drops of hydrochloric acid.
6/ Mark the last tube of rennin as 4 and add 5 drops of sodium hydroxide.
7/ After 2 minutes, neutralise the acid in tube 3 by adding 5 drops of sodium hydroxide and neutralise the base in tube 4 by adding 5 drops of acid.
8/ Place all four tubes in a beaker containing 100mls of tepid water(about 35 degrees), add 5mls of milk to each and test every minute whether surface milk will cling to a stirring rod.

Tube	Treatment	Time
1	None	
2	2 mins 60 degrees C	
3	2 mins Acid	
4	2 mins Base	

Result: Tube 1 formed into a gel in about 10 minutes, indicating activity of the rennin enzyme, however tubes 2, 3 and 4 showed little or no enzyme activity.

Conclusion: Rennin can have its enzymic activity permanently impaired through denaturation caused by high temperatures (above 40 degrees centigrade) or extremes of pH, either acid or alkaline.

Risk Level: Low Hazard: Sodium hydroxide is caustic and Hydrochloric acid is corrosive. Any skin contact with these reagents should be treated with prolonged washing in water.

STUDENT:____________________

266

Pasteurisation

Aim: To demonstrate that decay is not spontaneous but requires invisible microbes from the air.

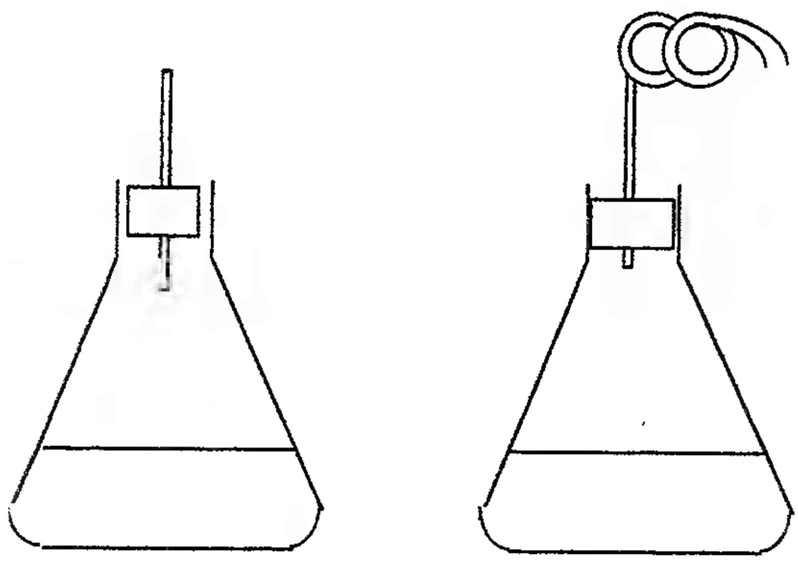
Equipment

Minced Beef
Conical Flasks, 250ml,two
Rubber Stoppers, two (with tubing hole)
Glass tubing 8mm X 8cm and 8mm X 25cm
Bunsen
Tripod
Vacuum grease

Pasteur pipettes, two
Microscope slides, two
Cover slips, two
Microscope

Procedure

1/ Add a teaspoon of mince to each conical flask.
2/ Add 100ml of water to each flask.
3/ Heat the long glass tubing over a Bunsen, rolling and moving a 10cm section over the flame until the glass softens. Bend the glass into a loop.
4/ Heat the next 10cm section of tubing to create a second loop. When both loops are complete the ends of the tube should be pointing in the same direction.
5/ Lightly grease one end of of the tube and carefully insert it into the hole in the rubber stopper.
6/ Insert the stoppers into the flasks.
7/ Grease and insert the short tubing into the other stopper.
7/ Heat each flask until the mixture boils for two minutes.
8/ Place both flasks on a shelf for 3 days.
9/ Use a Pasteur pipette to draw liquid from one flask and prepare a microscope slide. Repeat for the other flask.
10/ Examine both slides under a microscope at 400X magnification.



Results: ____

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Conclusion: ____

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266

Pasteurisation

Topics: Inside Life Consumer Science

Aim: To demonstrate that decay is not spontaneous but requires invisible microbes from the air.

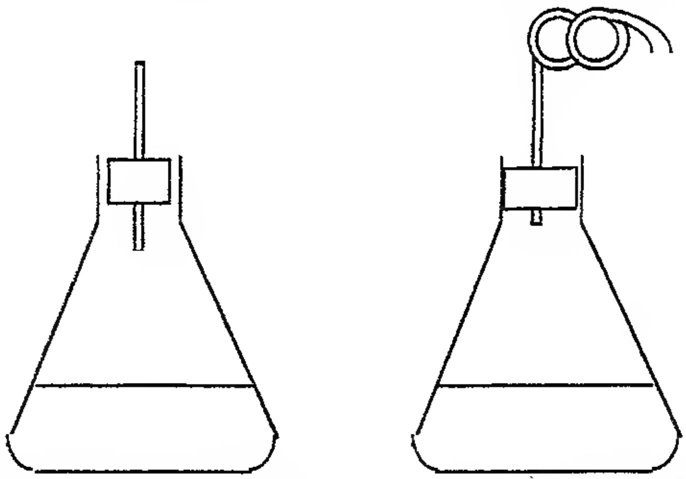
Equipment

Minced Beef
Conical Flasks, 250ml,two
Rubber Stoppers, two (with tubing hole)
Glass tubing 8mm X 8cm and 8mm X 25cm
Bunsen
Tripod
Vacuum grease

Pasteur pipettes, two
Microscope slides, two
Cover slips, two
Microscope

Procedure

1/ Add a teaspoon of mince to each conical flask.
2/ Add 100ml of water to each flask.
3/ Heat the long glass tubing over a Bunsen, rolling and moving a 10cm section over the flame until the glass softens. Bend the glass into a loop.
4/ Heat the next 10cm section of tubing to create a second loop. When both loops are complete the ends of the tube should be pointing in the same direction.
5/ Lightly grease one end of of the tube and carefully insert it into the hole in the rubber stopper.
6/ Insert the stoppers into the flasks.
7/ Grease and insert the short tubing into the other stopper.
7/ Heat each flask until the mixture boils for two minutes.
8/ Place both flasks on a shelf for 3 days.
9/ Use a Pasteur pipette to draw liquid from one flask and prepare a microscope slide. Repeat for the other flask.
10/ Examine both slides under a microscope at 400X magnification.



Result: The fluid in the flask with straight tubing was full of bacteria while the fluid in the other flask was sterile.

Conclusion: Boiling the flasks killed any microbes already inside. The flask with twisted glass tubing was sealed by condensed steam which formed a water loop. After three days microbes had entered the flask with straight tubing and multiplied. The mixture in the sealed flask was free of microbes and preserved by pasteurisation (boiling and sealing).

Risk Level: Moderate Hazard: Caution students only to handle the ends of the heated glass tubing and not to pick up any tubing which may still be hot. Great care should be used while inserting glass tubing into stoppers since the tubing easily shatters. Heavy garden gloves may be advisable.

STUDENT:____________________

267

Rubber Bones

Aim: To observe the collagen matrix of bones by dissolving the carbonate component of the bones.

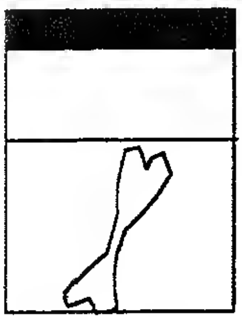
Equipment

Chicken bones (leg or wish bones)
Vinegar
Jars, 200ml, two

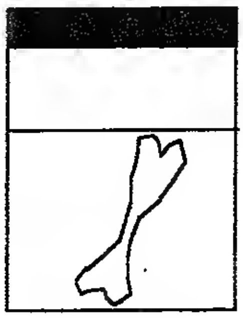
Procedure

1/ Place one chicken bone in a jar of water.
2/ Place another chicken bone in a jar of vinegar.
3/ Replace the vinegar every 2 days for a week.
4/ Remove and wash the bones then compare their rigidity.
5/ Compare the strength of the water soaked bone to the strength of a stick of chalk.

- write a general equation for the reaction of the acid vinegar with the carbonates in the bone.



Water



Vinegar

Results: ____

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Conclusion: ____

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267

Rubber Bones

Topics: Inside Life Acids & bases

Aim: To observe the collagen matrix of bones by dissolving the carbonate component of the bones.

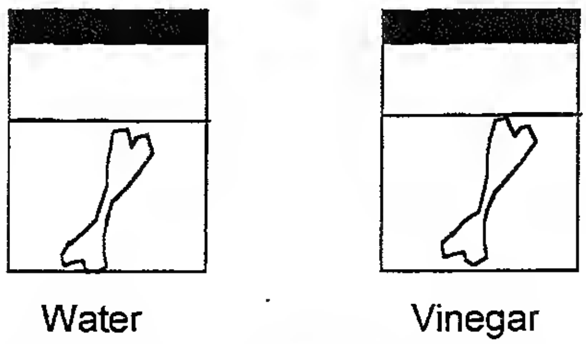
Equipment

Chicken bones (leg or wish bones)
Vinegar
Jars, 200ml, two

Procedure

1/ Place one chicken bone in a jar of water.
2/ Place another chicken bone in a jar of vinegar.
3/ Replace the vinegar every 2 days for a week.
4/ Remove and wash the bones then compare their rigidity.
5/ Compare the strength of the water soaked bone to the strength of a stick of chalk.

- write a general equation for the reaction of the acid vinegar with the carbonates in the bone.



Result: The bone soaked in vinegar was flexible enough to tie in a knot.

Conclusion: The acid in the vinegar reacted with the carbonate deposits in the bone (acid + carbonate > salt + water + carbon dioxide). The bone still looked whole due to the remaining collagen matrix, however this matrix is flexible. Carbonate deposits make the bone rigid but the collagen matrix gives the bone much greater strength than a stick of chalk.

Risk Level: Low Hazard:

STUDENT:____________________

268 Electrolytes

Aim: To measure the conductivity of various solutions of the same concentration as a means of comparing the degree of ionisation.

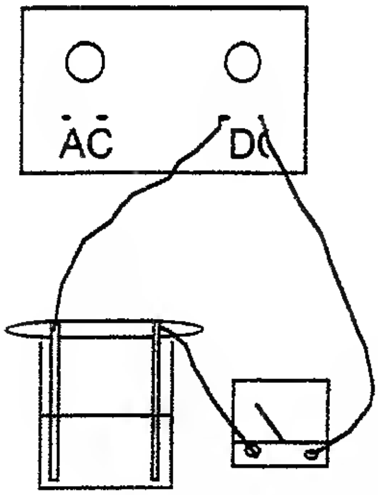
Equipment

Paddle pop stick
Alligator clips,two
Beaker 250 ml
Connecting wires,three
Milli ammeter (or multimeter)
Copper electrodes,two
Steel wool
Power supply, 0-12V DC
Test Solutions in beakers:
Hydrochloric acid 0.1M,1%
Sucrose, 0.1M, 3.4%
Acetic acid, 0.1M, 0.6%
Sodium Chloride,0.1M 0.6%
Ethanol, 0.1M, 0.6%
Ammonia, 0.1M, 0.7%
Nitric Acid ,0.1M, 0.6%

Procedure

Substances dissolve in water by reducing to individual molecules and ions. Not all substances completely dissociate into ions. Since ions conduct electricity in a solution, the amount of current flow should reflect the degree of ionisation.

1/ Clean two copper electrodes with steel wool.
3/ Insert the electrodes into the solution on opposite sides of a beaker of test solution. Hold the electrodes in place by fastenning to a paddle pop stick with alligator clips.
4/ Connect one alligator clip to the positive terminal of the ammeter.
5/ Connect the negative ammeter terminal to the negative DC terminal of the power supply.
6/ Connect the remaining alligator clip to the positive DC terminal of the power supply.
7/ Set the power supply to 2V and record the meter reading.
8/ Rinse the electrodes in a beaker of water then measure the current flow in another test solution.
9/ Repeat step 8 until all the solutions have been tested.



Solution	Current
Hydrochloric Acid	
Sucrose	
Sodium Chloride	
Acetic Acid	
Ethanol	
Ammonia	
Nitric Acid	

Results: ____

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Conclusion: ____

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Electrolytes

Topics: Ions Acids & Bases

Aim: To measure the conductivity of various solutions of the same concentration as a means of comparing the degree of ionisation.

Equipment

Paddle pop stick
Alligator clips,two
Beaker 250 ml
Connecting wires,three
Milli ammeter (or multimeter)
Copper electrodes,two
Steel wool
Power supply, 0-12V DC
Test Solutions in beakers:
Hydrochloric acid 0.1M,1%
Sucrose, 0.1M, 3.4%
Acetic acid, 0.1M, 0.6%
Sodium Chloride,0.1M 0.6%
Ethanol, 0.1M, 0.6%
Ammonia, 0.1M, 0.7%
Nitric Acid ,0.1M, 0.6%

Procedure

Substances dissolve in water by reducing to individual molecules and ions. Not all substances completely dissociate into ions. Since ions conduct electricity in a solution, the amount of current flow should reflect the degree of ionisation.

1/ Clean two copper electrodes with steel wool.
3/ Insert the electrodes into the solution on opposite sides of a beaker of test solution. Hold the electrodes in place by fastening to a paddle pop stick with alligator clips.
4/ Connect one clip to the positive terminal of the ammeter.
5/ Connect the negative ammeter terminal to the negative DC terminal of the power supply.
6/ Connect the remaining alligator clip to the positive DC terminal of the power supply.
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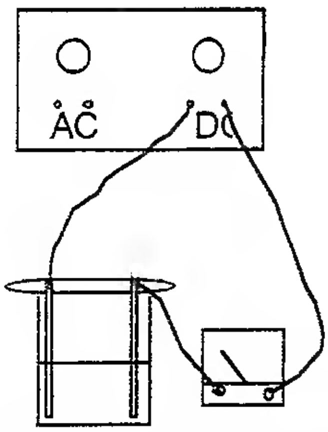


Solution	Current
Hydrochloric Acid	
Sucrose	
Sodium Chloride	
Acetic Acid	
Ethanol	
Ammonia	
Nitric Acid	

Result: Hydrochloric acid, sodium chloride and nitric acid gave high conductivity readings. Acetic acid and ammonia passed a reduced current while sucrose and ethanol passed very little current.

Conclusion: Hydrochloric acid, sodium chloride and nitric acid completely dissociate into ions. Ammonia and acetic acid only partially dissociate into ions. Ethanol and sucrose remain mostly in a molecular form in solution.
Note : All the test solutions are monoprotic.

Risk Level: Low Hazard: All the test solutions are of low toxicity and minimally corrosive at these concentrations.

STUDENT:______________

269 Electrophoresis

Aim: To demonstrate that ions move under the influence of an electric current.

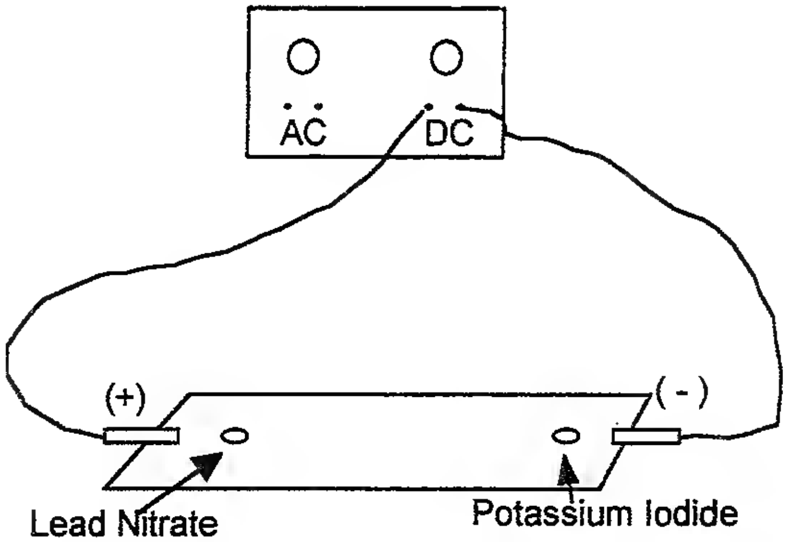
Equipment

Microscope slides, two
Filter papers, two
scissors
Lead Nitrate, 1M (33%) in a dropper bottle.
Potassium Iodide, 1M (17%) in dropper bottle.
Connecting leads, two
Power supply, 0-12V DC

Procedure

1/ Trace the outline of a glass slide on each filter paper.
2/ Cut out the traced rectangle (removing the drawn lines).
3/ Place a paper rectangle on each slide.
4/ Moisten the paper rectangles with a few drops of water.
5/ Place a drop of Potassium iodide solution on the right hand side of each slide.
6/ Place a drop of lead nitrate on the left hand side of each slide.
7/ Fasten alligator clips to each end of **one** slide.
8/ Connect the left clip to the positive DC terminal of the power supply.
9/ Connect the right clip to the negative DC terminal of the power supply.
10/ Set the voltage to 12V DC and turn on the power for about 40 minutes.

Lead iodide is a yellow and insoluable.



Results: ____

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Conclusion: ____

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269

Electrophoresis

Topics: Ions

Aim: To demonstrate that ions move under the influence of an electric current.

Equipment

Microscope slides, two
Filter papers, two
scissors
Lead Nitrate, 1M (33%) in a dropper bottle.
Potassium Iodide, 1M (17%) in dropper bottle.
Connecting leads, two
Power supply, 0-12V DC

Procedure

1/ Trace the outline of a glass slide on each filter paper.
2/ Cut out the traced rectangle (removing the drawn lines).
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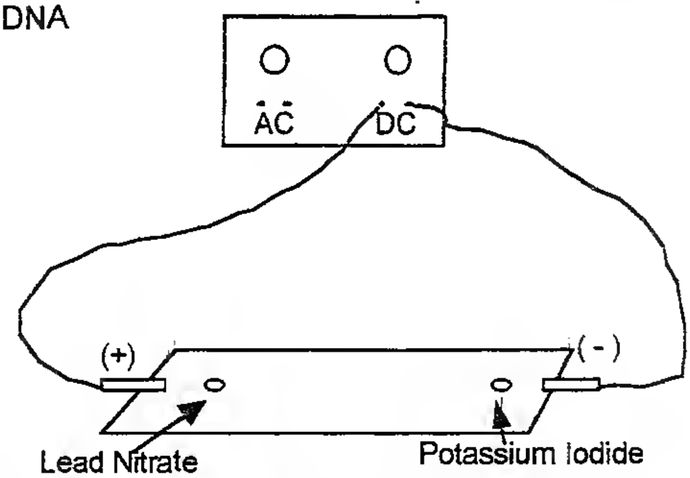
5/ Place a drop of Potassium iodide solution on the right hand side of each slide.
6/ Place a drop of lead nitrate on the left hand side of each slide.
7/ Fasten alligator clips to each end of **one** slide.
8/ Connect the left clip to the positive DC terminal of the power supply.
9/ Connect the right clip to the negative DC terminal of the power supply.
10/ Set the voltage to 12V DC and turn on the power for about 40 minutes.

Moving ions in a conducting strip is called electrophoresis and is a central technique in DNA finger printing.

Lead iodide is a yellow and insoluble.



Result: No change was seen in the slide without applied current. A yellow strip appeared near the centre of the slide with applied current.

Conclusion: Under the influence of an electric potential negative iodine ions moved toward the positive clip (anode) while positive lead ions moved toward the negative electrode (cathode). Where the lead and iodine ions met they formed a band of yellow lead iodide.

Risk Level: Mild Hazard: Lead nitrate is a cumulative toxin and ingestion or skin contact should be avoided. Potassium iodide is harmful if continually ingested.

STUDENT:____________________

270

Dissolving

Aim: To determine how much sugar can be dissolved in 80ml of water.

Equipment

Sugar
Beaker, 150ml
Stirring Rod
Balance, 0.1g
Measuring cylinder
Paper cup

Procedure

1/ Measure 80mls of water into the beaker.
2/ Weigh 100gms of sugar in a paper cup and add it to the water.
3/ Stir until the sugar has dissolved
4/ Weigh 10g of sugar and add it to the water.
5/ Stir the sugar until it dissolves.
6/ If the sugar dissolves make a tally mark in the table below.
7/ Keep repeating the last three steps until no more sugar will dissolve.
8/ Pour the solution into the measuring cylinder and record its volume.

- The sugar has dissolved forming a SOLUTION of sugar and water. In this solution the sugar is called the SOLUTE and the water is called the SOLVENT (a liquid which can dissolve substances).

- How much solute is in this solution?
- How much solvent is in the solution?
- What is the volume of the solution?
- Where did all the sugar go?

Total	Total
100g	170g
110g	180g
120g	190g
130g	200g
140g	210g
150g	220g
160g	230g

Final Volume	

Results: ____

____

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Conclusion: ____

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270

Dissolving

Topics: Kinetic Theory Matter

Aim: To determine how much sugar can be dissolved in 80ml of water.

Equipment

Sugar
Beaker, 150ml
Stirring Rod
Balance, 0.1g
Measuring cylinder
Paper cup

A surprisingly good experiment for year 7.

Procedure

1/ Measure 80mls of water into the beaker.
2/ Weigh 100gms of sugar in a paper cup.
3/ Add the sugar to the water, stirring until it all has dissolved.
4/ Weigh 10g of sugar and add it to the water.
5/ Stir the sugar until it dissolves.
6/ If the sugar dissolves make a tally mark in the table below.
7/ Keep repeating the last three steps until no more sugar will dissolve.
8/ Pour the solution into the measuring cylinder and record its volume.

- The sugar has dissolved forming a SOLUTION of sugar and water. In this solution the sugar is called the SOLUTE and the water is called the SOLVENT (a liquid which can dissolve substances).

- How much solute is in this solution?
- How much solvent is in the solution?
- What is the volume of the solution?
- Where did all the sugar go?

Total	Total
100g	170g
110g	180g
120g	190g
130g	200g
140g	210g
150g	220g
160g	230g
Final Volume	

Result: Over 200 g of sugar dissolved in the water yet the volume of the solution only increased slightly.

Conclusion: Sugar is the solute and water is the solvent. Solid crystals of sugar are composed of sugar molecules in a regular pattern. In water the sugar molecules separate mixing among and between the water molecules. The volume of the solution increases only slightly because the solid sugar is mostly empty space and there is much empty space in the water.

Risk Level: Low Hazard:

STUDENT:________________

271

Hot Cooling

Aim: To observe a latent energy release during a change of state.

Equipment

Test Tube, medium
Sodium Thiosulfate
Thermometer, 0 -110 C,
Bunsen
Retort stand
Clamp and boss head

Procedure

1/ Place two cm of sodium thiosulfate (hypo) in the test tube.
2/ Mount the test tube in a clamp on the retort stand above the bunsen.
3/ Adjust the bunsen to a clear flame and heat the test tube gently until the sodium thiosulfate melts. DO NOT OVER HEAT.
4/ Carefully place the thermometer into the molten thiosulfate.
5/ Record the temperture every 15 seconds as the compound cools.
6/ Convert the results into a graph of temperature versus time.

- Could your results explain why people say it is warmer while snow is falling?
- Gently submerse the test tubes and thermometers in a washing tray to dissolve the thiosulfate.

Time (mins)	Temp.	Time (mins)	Temp
0.00		2.50	
0.25		2.75	
0.50		3.00	
0.75		3.25	
1.00		3.50	
1.25		3.75	
1.50		4.00	
1.75		4.25	
2.00		4.50	
2.25		4.75	

Results: ____

____

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Conclusion: ____

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271

Hot Cooling

Topics: Kinetic Theory

Aim: To observe a latent energy release during a change of state.

Equipment

Test Tube, medium
Sodium Thiosulfate
Thermometer, 0 -110 C,
Bunsen
Retort stand
Clamp and boss head

Provide a long washing tray of water to dissolve the solidified hypo.

Procedure

1/ Place two cm of sodium thiosulfate (hypo) in the test tube.
2/ Mount the test tube in a clamp on the retort stand above the Bunsen.
3/ Adjust the Bunsen to a clear flame and heat the test tube gently until the sodium thiosulfate melts. DO NOT OVER HEAT.
4/ Carefully place the thermometer into the molten thiosulfate.
5/ Record the temperature every 30 seconds as the compound cools.
6/ Convert the results into a graph of temperature versus time.

- Could your results explain why people say it is warmer while snow is falling?
- Gently submerse the test tubes and thermometers in a washing tray to dissolve the thiosulfate.

Result: Initially the temperature fell, then rose as crystals formed then finally began to fall once again.

Conclusion: As a liquid changes state into a solid it releases energy called latent heat. As water vapour freezes into snow flakes it also releases latent heat which temporarily warms the surrounding air. Latent heat is a major energy source in cyclones and hurricanes. Such storms weaken over dry land where there is less water vapour to condense into clouds producing latent heat.

Risk Level: Moderate Hazard: Sodium thiosulfate can react violently with oxidising agents. Overheating sodium thiosulfate may produce corrosive sulfur dioxide fumes.

STUDENT:____________________

272 Concave Lens

Aim: To observe and record the effect of a concave lens on light rays and images.

Equipment

Hudson Ray Box
Power Supply 2-12V, DC
Concave lens(flat edge, vertically standing)
Concave lens, circular
Sheet of Paper
Paper glue

Procedure

1/ Place the flat edged lens on the piece of paper.
2/ Trace the outline of the lens.
3/Connect the ray box to the power supply (set at 6V)
4/ Insert the triple slit slide in front of the light to produce three parallel rays of light.
5/ Aim the rays straight onto the lens.
6/ Make some pencil dots to mark the path of the rays toward the lens and the refracted rays emerging.
7/ Join the dots with a ruler.
8/ Measure from the lens to where the rays converge (focus)
9/ Move the lens slightly below the first drawing
10/ Aim the light rays onto the lens but at an angle then repeat steps 2, 6 and 7.
11/ Paste both drawings in the space below.
12/ Write the word "Normal" on a strip of paper.
13/ Draw how the letters appear through the circular lens.
14/ Move the paper further away and draw the image.

Results: ____

____

____

Conclusion: ____

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272

Concave Lens

Topics: Light Waves

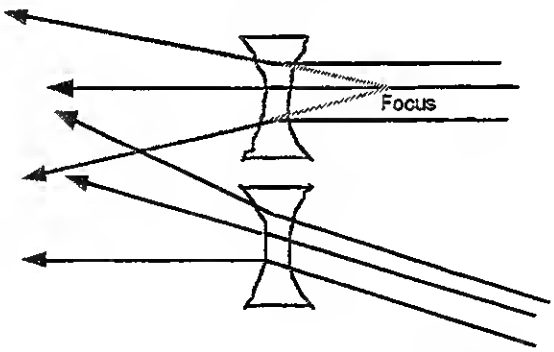
Aim: To observe and record the effect of a concave lens on light rays and images.

Equipment

Hudson Ray Box
Power Supply 2-12V, DC
Concave lens(flat edge, vertically standing)
Concave lens, circular
Sheet of Paper
Paper glue

Procedure

1/ Place the flat edged lens on the piece of paper.
2/ Trace the outline of the lens.
3/Connect the ray box to the power supply (set at 6V)
4/ Insert the triple slit slide in front of the light to produce three parallel rays of light.
5/ Aim the rays straight onto the lens.
6/ Make some pencil dots to mark the path of the rays toward the lens and the refracted rays emerging.
7/ Join the dots with a ruler.
8/ Measure from the lens to where the rays converge (focus)
9/ Move the lens slightly below the first drawing
10/ Aim the light rays onto the lens but at an angle then repeat steps 2, 6 and 7.
11/ Paste both drawings in the space below.
12/ Write the word "Normal" on a strip of paper.
13/ Draw how the letters appear through the circular lens.
14/ Move the paper further away and draw the image.



(Close)

(distant)

Result: Light rays passing through the lens are spread apart. Letters close to the lens appear smaller. Letters further from the lens appear very small.

Conclusion: Concave lenses refract parallel light rays so they spread apart as if they originated from the same point. Images seen through these lenses appear smaller and further away.

Risk Level: Low Hazard

STUDENT:____________________

273 Concave Mirror

Aim: To observe and record the effect of a concave mirror on light rays and images.

Equipment

Hudson Ray Box
Power Supply 2-12V, DC
Concave mirror (flat edge, vertically standing)
Concave mirror, circular
Sheet of Paper
Paper glue

Procedure

1/ Place the flat edged mirror on the piece of paper.
2/ Trace the outline of the mirror.
3/Connect the ray box to the power supply (set at 6V)
4/ Insert the triple slit slide in front of the light to produce three parallel rays of light.
5/ Aim the rays straight onto the mirror.
6/ Make some pencil dots to mark the path of the rays toward the mirror (Incident Rays) and the Reflected Rays.
7/ Join the dots with a ruler.
8/ Move the mirror slightly below the first drawing
9/ Aim the light rays onto the mirror but at an angle then repeat steps 6 and 7.
10/ Measure from the mirror to where the lines meet . Record this on the diagram as the "focal length."
10/ Paste both drawings in the space below.
11/ Write the word "Normal" on a strip of paper.
12/ Place the paper a few centimetres from the round mirror.
13/ Draw how the letters appear in the mirror.
14/ Move the paper one metre away and draw the image.

Results: ____

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Conclusion: ____

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273

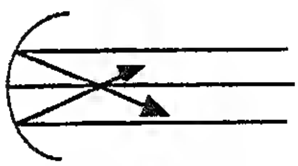
Concave Mirror

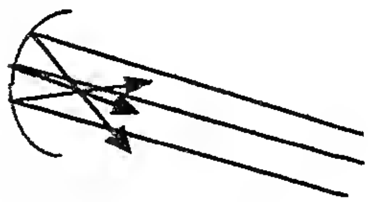
Topics: Light Waves

Aim: To observe and record the effect of a concave mirror on light rays and images.

Equipment
Hudson Ray Box
Power Supply 2-12V, DC
Concave mirror (flat edge, vertically standing)
Concave mirror, circular
Sheet of Paper
Paper glue

Procedure
1/ Place the flat edged mirror on the piece of paper.
2/ Trace the outline of the mirror.
3/Connect the ray box to the power supply (set at 6V)
4/ Insert the triple slit slide in front of the light to produce three parallel rays of light
5/ Aim the rays straight onto the mirror.
6/ Make some pencil dots to mark the path of the rays toward the mirror (Incident Rays) and the Reflected Rays.
7/ Join the dots with a ruler.
8/ Move the mirror slightly below the first drawing
9/ Aim the light rays onto the mirror but at an angle then repeat steps 6 and 7.
10/ Measure from the mirror to where the lines meet . Record this on the diagram as the "focal length."
10/ Paste both drawings in the space below.
11/ Write the word "Normal" on a strip of paper.
12/ Place the paper a few centimetres from the round mirror.
13/ Draw how the letters appear in the mirror.
14/ Move the paper one metre away and draw the image.





Normal

(Close)

(1 metre)

Result: The parallel rays are always reflected to meet at a point. Letters close to the mirror appear normal but magnified. Letters one metre from the mirror appear magnified, reversed and inverted.

Conclusion: Convex mirrors reflect parallel light rays to converge at a focus point. Images seen in these mirrors are magnified. Objects beyond the focal point of the mirror are still magnified but inverted both horizontally and vertically. Large images are warped toward the mirror edge.

Risk Level: Low Hazard.

STUDENT:__________________

274

Convex Lens

Aim: To observe and record the effect of a convex lens on light rays and images.

Equipment

Hudson Ray Box
Power Supply 2-12V, DC
Convex mirror (flat edge, vertically standing)
Convex mirror, circular
Sheet of Paper
Paper glue

Procedure

1/ Place the flat edged lens on the piece of paper.
2/ Trace the outline of the lens.
3/Connect the ray box to the power supply (set at 6V)
4/ Insert the triple slit slide in front of the light to produce three parallel rays of light.
5/ Aim the rays straight onto the lens.
6/ Make some pencil dots to mark the path of the rays toward the lens and the refracted rays emerging.
7/ Join the dots with a ruler.
8/ Measure from the lens to where the rays meet (focus)
9/ Move the lens slightly below the first drawing
10/ Aim the light rays onto the lens but at an angle then repeat steps 2, 6 and 7.
11/ Paste both drawings in the space below.
12/ Write the word "Normal" on a strip of paper.
13/ Draw how the letters appear through the circular lens.
14/ Move the paper further away and draw the image.

Results: ____

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Conclusion: ____

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274

Convex Lens

Topics: Light Waves

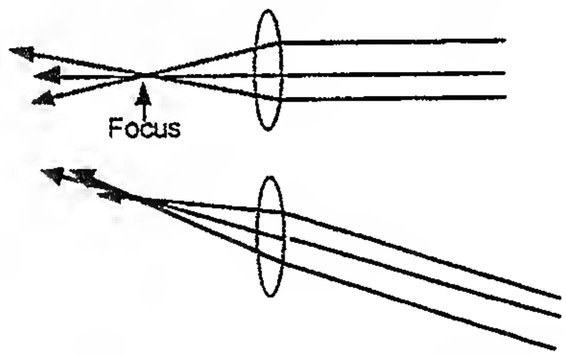
Aim: To observe and record the effect of a convex lens on light rays and images.

Equipment

Hudson Ray Box
Power Supply 2-12V, DC
Convex mirror (flat edge, vertically standing)
Convex mirror, circular
Sheet of Paper
Paper glue

Procedure

1/ Place the flat edged lens on the piece of paper.
2/ Trace the outline of the lens.
3/Connect the ray box to the power supply (set at 6V)
4/ Insert the triple slit slide in front of the light to produce three parallel rays of light.
5/ Aim the rays straight onto the lens.
6/ Make some pencil dots to mark the path of the rays toward the lens and the refracted rays emerging.
7/ Join the dots with a ruler.
8/ Measure from the lens to where the rays meet (focus)
9/ Move the lens slightly below the first drawing
10/ Aim the light rays onto the lens but at an angle then repeat steps 2, 6 and 7.
11/ Paste both drawings in the space below.
12/ Write the word "Normal" on a strip of paper.
13/ Draw how the letters appear through the circular lens.
14/ Move the paper further away and draw the image.



Normal   Normal

(Close)   (distant)

Result: The rays passing through the lens converge at a point. Letters close to the lens appear magnified. Letters further from the lens are inverted and reversed. At a point close to the focus the letters cannot be seen.

Conclusion: Convex lenses refract parallel light rays to converge at a focus point. Objects close to the lens are magnified. Objects further away appear inverted, magnified at first but less so with increasing distance from the lens.

Risk Level: Low Hazard

STUDENT:________________

275 Convex Mirror

Aim: To observe and record the effect of a convex mirror on light rays and images.

Equipment

Hudson Ray Box
Power Supply 2-12V, DC
Convex mirror (flat edge, vertically standing)
Convex mirror, circular
Sheet of Paper
Paper glue

Procedure

1/ Place the flat edged mirror on the piece of paper.
2/ Trace the outline of the mirror.
3/Connect the ray box to the power supply (set at 6V)
4/ Insert the triple slit slide in front of the light to produce three parallel rays of light.
5/ Aim the rays straight onto the mirror.
6/ Make some pencil dots to mark the path of the rays toward the mirror (Incident Rays) and the Reflected Rays.
7/ Join the dots with a ruler.
8/ Move the mirror slightly below the first drawing
9/ Aim the light rays onto the mirror but at an angle then repeat steps 6 and 7.
10/ Draw dotted lines extending the reflected rays back beyond the mirror. Wher the lines meet is called the focus.
11/ Paste both drawings in the space below.
12/ Write the word "Normal" on a strip of paper.
13/ Place the paper a few centimetres from the round mirror.
14/ Draw how the letters appear in the mirror.
15/ Move the paper one metre away and draw the image.

Results: ____

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Conclusion: ____

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275

Convex Mirror

Topics: Light Waves

Aim: To observe and record the effect of a convex mirror on light rays and images.

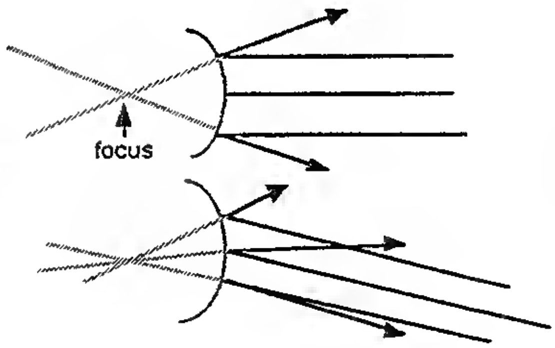
Equipment

Hudson Ray Box
Power Supply 2-12V, DC
Convex mirror (flat edge, vertically standing)
Convex mirror, circular
Sheet of Paper
Paper glue

Procedure

1/ Place the flat edged mirror on the piece of paper.
2/ Trace the outline of the mirror.
3/Connect the ray box to the power supply (set at 6V)
4/ Insert the triple slit slide in front of the light to produce three parallel rays of light.
5/ Aim the rays straight onto the mirror.
6/ Make some pencil dots to mark the path of the rays toward the mirror (Incident Rays) and the Reflected Rays.
7/ Join the dots with a ruler.
8/ Move the mirror slightly below the first drawing
9/ Aim the light rays onto the mirror but at an angle then repeat steps 6 and 7.
10/ Draw dotted lines extending the reflected rays back beyond the mirror. Wher the lines meet is called the focus.
11/ Paste both drawings in the space below.
12/ Write the word "Normal" on a strip of paper.
13/ Place the paper a few centimetres from the round mirror.
14/ Draw how the letters appear in the mirror.
15/ Move the paper one metre away and draw the image.

Normal
(Close)



Normal
(1 metre)

Result: Light rays reflected from a convex mirror are scattered. Images seen in the mirrors appear properly oriented but small.

Conclusion: Convex mirrors cause parallel light rays to diverge as if they originated from a point behind the mirror. The images produced are not inverted but are reduced in size. Convex mirrors are useful for a wide angle view eg. security mirrors in stores.

Risk Level: Low Hazard.

STUDENT:____________________

Flat Mirror

Aim: To observe and record the effect of a flat mirror on light rays and images.

Equipment

Hudson Ray Box
Power Supply 2-12V, DC
Flat Mirror
Sheet of Paper
Protractor

Procedure

1/ Place the flat mirror on one side of the piece of paper.
2/ Trace the outline of the mirror.
3/ Rule a line perpendicular to the centre of the mirror face. This line is called the "normal".
4/Connect the ray box to the power supply (set at 6V)
5/ Insert the single slit slide in front of the light to produce a ray of light.
6/ Aim the light ray where the Normal meets the mirror.
7/ Make some pencil dots to mark the path of the ray toward the mirror (Incident Ray) and the Reflected Ray.
8/ Join the dots with a ruler then use a protractor to measure the angle between Incident Ray and the normal.
9/ Measure the angle between the Reflected ray and the normal. Record both angles in the table below.
10/ Repeat the last four steps for two new angles.
11/ Write the word "Normal" on a strip of paper.
12/ Place the paper a few centimetres from the mirror.
13/ Observe how the letters appear in the mirror.

Line	Angle of Incidence	Angle of Reflection
1		
2		
3		

Results: ____

____

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Conclusion: ____

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276

Flat Mirror

Topics: Light Waves

Aim: To observe and record the effect of a flat mirror on light rays and images.

Equipment

Hudson Ray Box
Power Supply 2-12V, DC
Flat Mirror
Sheet of Paper
Protractor

Procedure

1/ Place the flat mirror on one side of the piece of paper.
2/ Trace the outline of the mirror.
3/ Rule a line perpendicular to the centre of the mirror face. This line is called the "normal".
4/Connect the ray box to the power supply (set at 6V)
5/ Insert the single slit slide in front of the light to produce a ray of light.
6/ Aim the light ray where the Normal meets the mirror.
7/ Make some pencil dots to mark the path of the ray toward the mirror (Incident Ray) and the Reflected Ray.
8/ Join the dots with a ruler then use a protractor to measure the angle between Incident Ray and the normal.
9/ Measure the angle between the Reflected ray and the normal. Record both angles in the table below.
10/ Repeat the last four steps for two new angles.
11/ Write the word "Normal" on a strip of paper.
12/ Place the paper a few centimetres from the mirror.
13/ Draw how the letters appear in the mirror.

Normal

Result: A flat mirror reflects a light ray at the same angle as it strikes the mirror.
Letters viewed in a mirror appear reversed (but not inverted).

Conclusion: The Law of Reflection: The angle of reflection equals the angle of incidence.
Flat mirrors invert an image only in the horizontal plane.

Risk Level: Low Hazard

STUDENT:________________

277

Arthropod Art

Aim: To classify and preserve a small arthropod in in a resin block.

Equipment

Casting Resin (two batches of 50ml each)
Plastic egg cup
Floor Polish
Capture Jar
Methanol
Pins, 12
styrofoam 5cm X 5cm
Turpentine
Wet & dry abrasive paper
Brass Polish
Packing Tape (labels)
Match sticks

Procedure

1/ Collect a small insect or spider (about 3cm max. diam.)
2/ Dehydrate in methanol for at least 1hour.
3/ Use pins to mount the specimen in a realistic pose on a labelled styrofoam base and allow to dry for one week.
4/ Rinse an egg cup with floor polish and wipe clean.
5/ Half fill a plastic egg cup with slow setting casting resin.
6/ Dip the dried specimen in turpentine and allow to drain on tissue paper.
7/ Use forceps to place the specimen on the soft resin. Use a match stick to gently immerse the specimen.
8/ After about 1.5hrs the resin will begin to gel. Pour fresh resin over the specimen to fill the egg cup.
9/ Allow the resin to set overnight. Remove the plastic block . Smooth and polish with wet & dry abrasive paper as needed.
10/ Final buff with brass polish.

- Use an identification key to fully classify your specimen.
- Write a report on the life cycle, food, habitat, special behaviours and features of your specimen.

Results: ____

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Conclusion: ____

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277

Arthropod Art

Topics: Living Things

Aim: To classify and preserve a small arthropod in in a resin block.

Equipment

Casting Resin (two batches of 50ml each)
Plastic egg cup
Floor Polish
Capture Jar
Methanol
Pins, 12
styrofoam 5cm X 5cm
Turpentine
Wet & dry abrasive paper
Brass Polish
Packing Tape (labels)
Match sticks

Casting Resin: 0.5ml hardener to 100ml resin. Use evaporating basins or spray can lids for larger specimens.

Procedure

1/ Collect a small insect or spider (about 3cm max. diam.)
2/ Dehydrate in methanol for at least 1hour.
3/ Use pins to mount the specimen in a realistic pose on a labelled styrofoam base and allow to dry for one week.
4/ Rinse an egg cup with floor polish and wipe clean.
5/ Half fill a plastic egg cup with slow setting casting resin.
6/ Dip the dried specimen in turpentine and allow to drain on tissue paper.
7/ Use forceps to place the specimen on the soft resin. Use a match stick to gently immerse the specimen.
8/ After about 1.5hrs the resin will begin to gel. Pour fresh resin over the specimen to fill the egg cup.
9/ Allow the resin to set overnight. Remove the plastic block . Smooth and polish with wet & dry abrasive paper as needed.
10/ Final buff with brass polish.

- Use an identification key to fully classify your specimen.
- Write a report on the life cycle, food, habitat, special behaviours and features of your specimen.

Result: The specimen is preserved in a clear magnifying dome of polymer resin

Conclusion: This activity is time consuming but adds real student interest to the study of invertebrates. Specimen catalogues show a well presented beetle to be valuable. Students can purchase their completed specimen at cost on condition of completing the classification and research assignment.

Risk Level: Mild Hazard: Good ventilation is essential throughout. Students should not mix or handle the liquid resin. Methanol and Turpentine are flammable and harmful if ingested. Skin contact with the liquid resin should be avoided. Use turpentine to clean resin spills. Slow setting resin is used to avoid damage to the specimen from the heat of polymerisation.

STUDENT:________________

278 # Gears and Torque

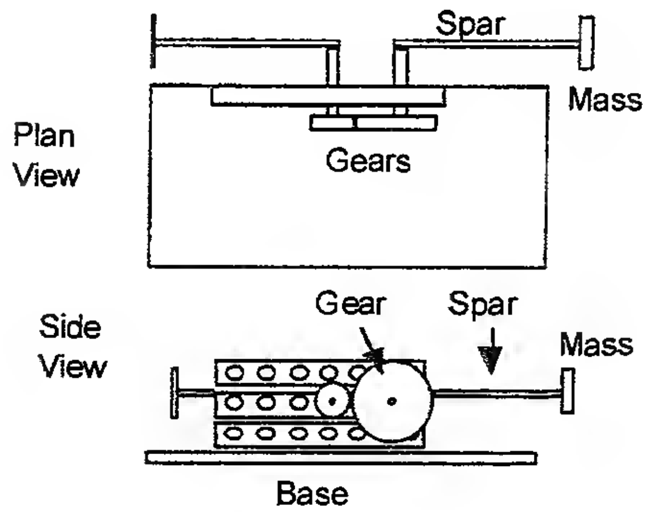
Aim: To examine the mechanical advantage of gears.

Equipment

Lego Technics Set
Masses,25g (one),
5g(three), 50g (one)

Procedure

1/ Build the simple Lego construction drawn below.
2/ Count the number of teeth on each gear and record the result in the table.
- How many times will the small gear wheel turn for each turn of the large gear wheel ?
3/ Adjust the axle spars so both are of equal length, horizontal and opposite.
4/ Slide the 25g mass onto the end of the spar connected to the axle of the large gear.
5/ Add 5g masses to the end of spar connected to the axle of the small gear until the forces balance.
6/ Record the result in the table
7/ Change the spar on the axle of the small gear so it is twice as long as the spar connected to the large gear.
8/ Change the mass on the large gear to 50g and add 5g masses to the small gear spar until the forces balance.
- Torque is a measure of force applied at an axle. What is the effect of doubling the spar length on torque?



Results: ____

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Conclusion: ____

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278

Gears and Torque

Topics: Machines

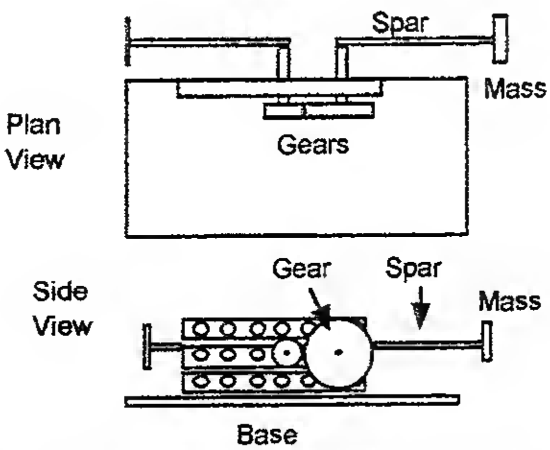
Aim: To examine the mechanical advantage of gears.

Equipment

Lego Technics Set
Masses,25g (one),
5g(three), 50g (one)

Procedure

1/ Build the simple Lego construction drawn below.
2/ Count the number of teeth on each gear and record the result in the table.
- How many times will the small gear wheel turn for each turn of the large gear wheel ?
3/ Adjust the axle spars so both are equal and opposite.
4/ Slide the 25g mass onto the end of the spar connected to the axle of the large gear.
5/ Add 5g masses to the end of spar connected to the axle of the small gear until the forces balance.
6/ Record the result in the table
7/ Change the spar on the axle of the small gear so it is twice as long as the spar connected to the large gear.
8/ Change the mass on the large gear to 50g and add 5g masses to the small gear spar until the forces balance.
- Torque is a measure of force applied at an axle. What is the effect of doubling the spar length on torque?



Result: Far less mass needs to be applied to the small gear to balance the large mass on the large gear.

Conclusion: The ratio of teeth numbers on gears is equal to the mechanical advantage supplied by the gears. A force is applied to an axle via a wheel or extended spar is called Torque. Doubling the radius of the wheel or the length of the spar doubles the torque at the axle.

Risk Level: Low Hazard

STUDENT:____________________

279

Inclined Plane

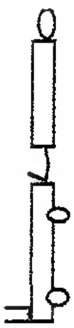
Aim: To measure the force required to raise an object with and without the use of an inclined plane.

Equipment

Newton Cart
Spring Balance, 10 N
Masses, 250g, two
Metre rule
Ramp, 1m long

Procedure

1/ Use the spring balance to measure the force required to lift the Newton Cart. Record all measurements in the table below.
2/ Position the ramp to run from the floor to a chair seat.
3/ Measure the height of the chair seat.
4/ Measure the length of the ramp.
5/ Measure the force required to pull the cart slowly up the ramp.
6/ Add one 250g mass to the cart.
7/ Measure the force need to pull the cart up the ramp and the force needed to directly lift the cart.
8/ Add another 250g mass to the cart and repeat step 7.
9/ Complete the calculations in the table.



Trial	Lift Force	Ramp Force	Lift F./Ramp F.
Cart			
Cart +250g			
Cart + 500g			
	Height	Length	Height/Length
Ramp			

Results: ____

____

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Conclusion: ____

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279

Inclined Plane

Topics: Machines Vectors

Aim: To measure the force required to raise an object with and without the use of an inclined plane.

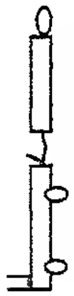
Equipment

Newton Cart
Spring Balance, 10 N
Masses, 250g, two
Metre rule
Ramp, 1m long

Procedure

1/ Use the spring balance to measure the force required to lift the Newton Cart. Record all measurements in the table below.
2/ Position the ramp to run from the floor to a chair seat.
3/ Measure the height of the chair seat.
4/ Measure the length of the ramp.
5/ Measure the force required to pull the cart slowly up the ramp.
6/ Add one 250g mass to the cart.
7/ Measure the force need to pull the cart up the ramp and the force needed to directly lift the cart.
8/ Add another 250g mass to the cart and repeat step 7.
9/ Complete the calculations in the table.

String may be needed if the cart lacks a hook eye for the spring balance.



Trial	Lift Force	Ramp Force	Lift F./Ramp F.
Cart			
Cart +250g			
Cart + 500g			
	Height	Length	Height/Length
Ramp			

Result: The force required to pull the cart up the ramp was much less than the force needed to lift the cart directly. The ratio of these to forces was equal to the ratio of the length and height of the ramp.

Conclusion: A ramp is a simple machine that reduces the force required to raise an object. The force required to raise the object is reduced in proportion to the length of the ramp divided by its height.

Risk Level: Low Hazard:

STUDENT:____________________

280

Pulleys

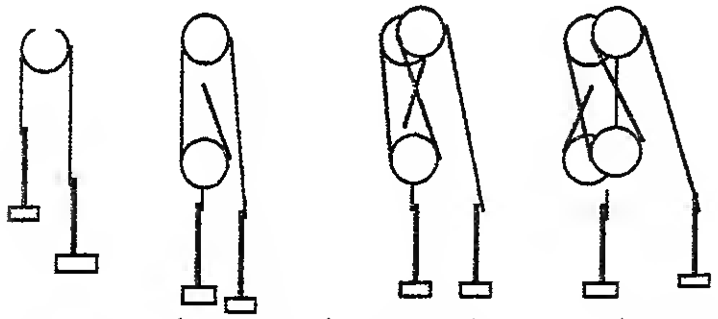
Aim: To examine pulleys as force magnifying machines.

Equipment

Single pulleys, two
Double wheel pulleys, two
Retort stand,
Clamp and boss head,
Pulley string, 1.5m
Mass Carriers, two
Masses, 50g (seven)
25g(two), 5g (two)

Procedure

1/ Use the retort stand to support a single pulley over the edge of the bench.
2/ Pass the string through the pulley.
3/ Loosely tie a mass carrier at one end and add four 50g masses ie. total mass 250g
4/ Loosely tie the other mass carrier to the opposite end of the string. Add masses until the carriers balance. Record the balancing mass in the table below.
5/ Untie the string and pass it through two single pulleys as shown below.
6/ Record the mass required to balance 250g.
7/ Untie the string and pass it through one single pulley and one double pulley as shown.
8/ Record the mass required to balance 250g.
9/ Untie the string and pass it through two double pulleys as shown.
10/ Record the mass required to balance 250g.
11/ Complete the table.



Pulleys	1	2	3	4
Load	250g	250g	250g	250g
Mass				
Load / Mass				

Results: ____

____

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Conclusion: ____

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280

Pulleys

Topics: Machines Work

Aim: To examine pulleys as force magnifying machines.

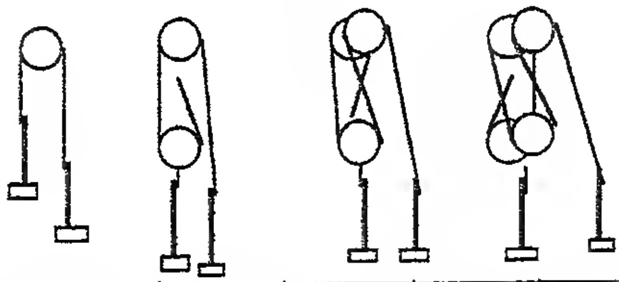
Equipment

Single pulleys, two
Double wheel pulleys, two
Retort stand,
Clamp and boss head,
Pulley string, 1.5m
Mass Carriers, two
Masses, 50g (seven)
25g(two), 5g (two)

If equipment is in short supply have some of the class do "Gears" or "Inclined Plane".

Procedure

1/ Use the retort stand to support a single pulley over the edge of the bench.
2/ Pass the string through the pulley.
3/ Loosely tie a mass carrier at one end and add four 50g masses ie. total mass 250g
4/ Loosely tie the other mass carrier to the opposite end of the string. Add masses until the carriers balance. Record the balancing mass in the table below.
5/ Untie the string and pass it through two single pulleys as shown below.
6/ Record the mass required to balance 250g.
7/ Untie the string and pass it through one single pulley and one double pulley as shown.
8/ Record the mass required to balance 250g.
9/ Untie the string and pass it through two double pulleys.
10/ Record the mass required to balance 250g.
11/ Complete the table.



Pulleys	1	2	3	4
Load	250g	250g	250g	250g
Mass				
Load / Mass				

Result: One pulley did not reduce the mass required to balance 250g. Increasing the number of pulleys decreased the mass required to balance 250g.

Conclusion: Pulleys as simple force magnifying machines, the force applied being magnified by the number of pulley wheels. That is the mechanical advantage of a pulley system is equal to the number of pulley wheels. Point out to the students that for a mechanical advantage of 4, the applied force must move four times further than the weight.

Risk Level: Low Hazard:

STUDENT:____________________

281 Wheel barrow

Aim: To examine the properties of a wheel barrow as a second order lever.

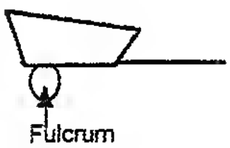
Equipment

Wheel barrow
Two concrete blocks or 8 house bricks

Procedure

1/ Place the bricks in the barrow over the wheel .
2/ Lift the barrow by the end of the handles.
3/ On the diagram provided draw the position of the load with a downward arrow and the position of your hands with an upward arrow.
4/ On the line below the diagram record whether the lift is easy or hard.
5/ Lower the barrow and slide your hands along the handles to the bucket. Lift the barrow again.
6/ Record the load and effort positions on the next diagram and whether the lift is easier or harder.
7/ Move the bricks close to the handles.
8/ Lift with your hands close to the bucket.
9/ Repeat step 7.
10/ Lift by the end of the handles and repeat step 7.
11/ Compare the relative distance of the load and effort from the fulcrum in each diagram.

Situation 1



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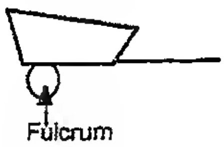
Situation 2



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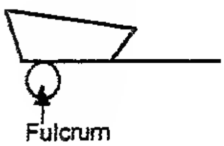
Situation 3



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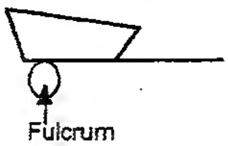
Situation 4



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Results: ____

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Conclusion: ____

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281

Wheel barrow

Topics: Machines

Aim: To examine the properties of a wheel barrow as a second order lever.

Equipment

Wheel barrow

Two concrete blocks or 8 house bricks

Procedure

1/ Place the bricks in the barrow over the wheel .

2/ Lift the barrow by the end of the handles.

3/ On the diagram provided draw the position of the load with a downward arrow and the position of your hands with an upward arrow.

4/ On the line below the diagram record whether the lift is easy or hard.

5/ Lower the barrow and slide your hands along the handles to the bucket. Lift the barrow again.

6/ Record the load and effort positions on the next diagram and whether the lift is easier or harder.

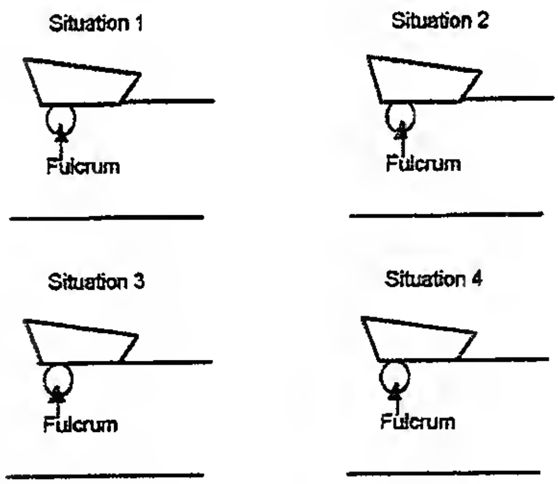
7/ Move the bricks close to the handles.

8/ Lift with your hands close to the bucket.

9/ Repeat step 7.

10/ Lift by the end of the handles and repeat step 7.

11/ Compare the relative distance of the load and effort from the fulcrum in each diagram.



Result: Lifting is easiest in situation 1, harder in situation 2, harder again in situation 3 and then a bit easier in situation 4.

Conclusion: The least effort is required to lift the barrow when the distance of the effort to the fulcrum is much greater than the distance of the load to the fulcrum.

Risk Level: Low Hazard but supervision is necessary to stop showing off and to ensure a load is not spilled onto a student.

STUDENT:________________

Electromagnets 1

Aim: To produce a magnetic field from current in a coil of wire.

Equipment

150mm Iron nail or bolt
Insulated wire, 1m
Power supply 2-12V DC
Connecting wires, 2
Steel paper clips
Magnetic Compass
Adhesive Tape

Procedure

1/ Wind the insulated wire around the iron nail in even, tight coils, from one end to the other and then back in a second layer.
2/ Use adhesive tape to bind the coil, leaving the two ends free.
3/ Use the connecting wires to link the positive terminal of the power supply to one free end of the wire coil and the negative terminal to the other free end.
4/ Set the power supply to 2V DC
5/ Place a compass near one end of the nail
6/ Turn on the power briefly and record the behaviour of the magnet.
7/ Swap the power supply connections and repeat step 6.
8/ Place the paper clips 1cm from the end of the nail, briefly turn on the power and record what happens.
9/ Carefully remove the iron nail from the coil and repeat the last step using the hollow coil instead

Results: ____

____

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Conclusion: ____

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282

Electromagnets 1

Topics: Magnetism Forces Electromagnetism

Aim: To produce a magnetic field from current in a coil of wire.

Equipment

150mm Iron nail or bolt
Insulated wire,1m
Power supply 2-12V DC
Connecting wires,2
Steel paper clips
Magnetic Compass
Adhesive Tape

Procedure

1/ Wind the insulated wire around the iron nail in even, tight coils, from one end to the other and then back in a second layer.
2/ Use adhesive tape to bind the coil, leaving the two ends free.
3/ Use the connecting wires to link the positive terminal of the power supply to one free end of the wire coil and the negative terminal to the other free end.
4/ Set the power supply to 2V DC
5/ Place a compass near one end of the nail
6/ Turn on the power briefly and record the behaviour of the magnet.
7/ Swap the power supply connections and repeat step 6.
8/ Place the paper clips 1cm from the end of the nail, briefly turn on the power and record what happens.
9/ Carefully remove the iron nail from the coil and repeat the last step using the hollow coil instead.

Result: The compass needle swung toward the electromagnet. When the current was reversed the compass needle swung to the opposite direction. When the nail was removed the electromagnet was much weaker.

Conclusion: A magnetic field is created when electric current flows in a coil of wire. The field is reversed if the current is reversed. The field is much stronger if the coil is wound around an iron core.

Risk Level: Low Hazard; Higher voltage settings will overload the power supplies. The units may automatically reset after a few seconds or internal fuses may need to be replaced.

STUDENT:________________

283

Electromagnets 2

Aim: To investigate the variables affecting the magnetic field produced by a current in a coil of wire.

Equipment

150mm Iron nail or bolt
Insulated wire,1m
Power supply 2-12V DC
Connecting wires,3
Retort Stand, boss head
Spring Balance,5N
Adhesive Tape

Procedure

1/ Wind the insulated wire around the iron nail in even, tight coils, from one end to the other and then back in a second layer. Bind the coil with tape, leaving the two ends free.
2/ Use the connecting wires to link the terminals of the power supply to one free ends of the wire coil.
3/ Tape a bar magnet to the hook of the spring balance (North Pole downward). Suspend the balance on the stand.
4/ Record the balance reading in the table provided.
5/ Turn on the power at 2 V DC and bring one pole of the electromagnet to 2cm below the bar magnet.
6/ Record the balance reading.
7/ Repeat the readings using 4V DC.
8/ Repeat the readings at 2V DC, power terminals reversed.
9/ Unwind the out layer of windings and repeat the reading.
10/ Draw a diagram of your electromagnet in the space at left, indicating the direction of current flow and direction of the magnetic field produced.

Trial	Balance Reading	Force (Newtons)
Bar magnet alone		0
Electromagnet at 2V		
Electromagnet at 4V		
Electromagnet at 2V reversed		
Electromagnet at 2V, half windings		

Results: ____

____

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Conclusion: ____

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283

Electromagnets 2

Topics: Magnetism Forces Electromagnetism

Aim: To investigate the variables affecting the magnetic field produced by a current in a coil of wire.

Equipment

150mm Iron nail or bolt
Insulated wire,1m
Power supply 2-12V DC
Connecting wires,3
Retort Stand, boss head
Spring Balance,5N
Adhesive Tape

Procedure

1/ Wind the insulated wire around the iron nail in even, tight coils, from one end to the other and then back in a second layer. Bind the coil with tape, leaving the two ends free.
2/ Use the connecting wires to link the terminals of the power supply to one free ends of the wire coil.
3/ Tape a bar magnet to the hook of the spring balance (North Pole downward). Suspend the balance on the stand.
4/ Record the balance reading in the table provided.
5/ Turn on the power at 2 V DC and bring one pole of the electromagnet to 2cm below the bar magnet.
6/ Record the balance reading.
7/ Repeat the readings using 4V DC.
8/ Repeat the readings at 2V DC, power terminals reversed.
9/ Unwind the out layer of windings and repeat the reading.
10/ Draw a diagram of your electromagnet in the space at left, indicating the direction of current flow and direction of the magnetic field produced.

Trial	Balance Reading	Force (Newtons)
Bar magnet alone		0
Electromagnet at 2V		
Electromagnet at 4V		
Electromagnet at 2V reversed		
Electromagnet at 2V, half windings		

Result: Increasing voltage increased the magnetic field produced. Reversing voltage reversed the magnetic field. Reducing the number of windings reduced the magnetic field produced.

Conclusion: A magnetic field is created when electric current flows in a coil of wire. The direction of the field is dependent on the direction of the current (right hand rule). The strength of the field is proportional to the number of coils and to the size of the current (current is proportional to applied voltage).

Risk Level: Low Hazard; Higher voltage settings will overload the power supplies. The units may automatically reset after a few seconds or internal fuses may need to be replaced.

STUDENT:________________

Invisible Force

Aim: To determine whether invisible magnetic force lines can be blocked by various materials.

Equipment

Spring Balance ,5N
Bar Magnets, 2
Adhesive tape
Copper sheet
glass slide
Retort stand, boss head
heat mat
plastic sheet

Procedure

1/ Suspend the spring balance from the boss head on the retort stand.
2/ Tape a bar magnet to the balance hook, North Pole facing down.
3/ Record the reading on the balance in the table provided.
4/ Position the South Pole of the second magnet so it is 2cm below the suspended magnet and record the new balance reading.
5/ Place a sample of the following materials between the magnets, recording the balance reading each time:
- copper sheet
- glass slide
- wooden ruler
- pages of your book
- plastic sheet
- heat mat

6/ Complete the table

Trial	Balance Reading	Force (Newtons)
One Magnet		0
Both Magnets		
Both Magnets, Copper sheet		
Both Magnets, glass slide		
Both Magnets, wooden ruler		
Both Magnets, paper		
Both Magnets, heat mat		
Both Magnets, plastic		

Results: ____

____

____

Conclusion: ____

____

____

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284

Invisible Force

Topics: Magnetism Forces

Aim: To determine whether invisible magnetic force lines can be blocked by various materials.

Equipment

Spring Balance ,5N
Bar Magnets, 2
Adhesive tape
Copper sheet
glass slide
Retort stand, boss head
heat mat
plastic sheet

Procedure

1/ Suspend the spring balance from the boss head on the retort stand.
2/ Tape a bar magnet to the balance hook, North Pole facing down.
3/ Record the reading on the balance in the table provided.
4/ Position the South Pole of the second magnet so it is 2cm below the suspended magnet and record the new balance reading.
5/ Place a sample of the following materials between the magnets, recording the balance reading each time:
copper sheet
glass slide
wooden ruler
pages of your book
plastic sheet
heat mat
6/ Complete the table

Trial	Balance Reading	Force (Newtons)
One Magnet		0
Both Magnets		
Both Magnets, Copper sheet		
Both Magnets, glass slide		
Both Magnets, wooden ruler		
Both Magnets, paper		
Both Magnets, heat mat		
Both Magnets, plastic		

Result: Positioning the second magnet increased the balance reading but interposing materials between the magnets caused no change.

Conclusion: Invisible lines of magnetic force between the magnets could not be blocked with any of the materials tested.

Risk Level: Low Hazard

STUDENT:____________________

285

Alloys

Aim: To make a metallic alloy.

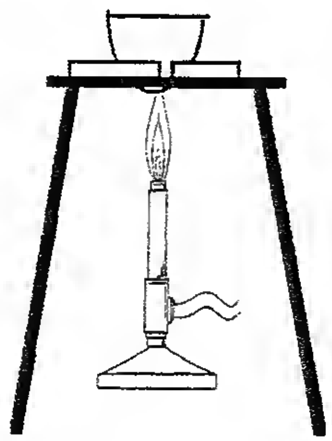
Equipment

Tin granules
Lead Shot
Crucible
Pipe clay triangle
Tripod
Bunsen

Procedure

An alloy is formed when two metalic elements are mixed together to form a substance which has the combined properties of the original metals. No chemical reaction has taken place.
Silver coloured coins are an alloy of nickel and tin.
Brass is an alloy of copper and tin.
Golden coins are an alloy of nickel, copper and aluminium.

1/ Add a ten grains of lead shot to a crucible. Lead is a soft, grey metal.
2/ Add two granules of tin to the crucible. Tin is a hard, shiny mtal.
3/ Place the crucible in a pipe clay tiangle on top of a tripod.
4/ Heat the crucible with tip of a blue bunsen flame until both metals have melted and mixed.
DO NOT BREATH ANY FUMES FROM THE CRUCIBLE.
- Which metal melted first?
5/ Allow the crucible to cool for at least five minutes.
6/ Remove the disk of metal which has formed and descibe its properties.



Results: ____

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Conclusion: ____

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285

Alloys

Topics: Matter Elements

Aim: To make a metallic alloy.

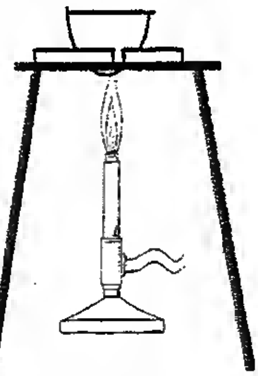
Equipment

Tin granules
Lead Shot
Crucible
Pipe clay triangle
Tripod
Bunsen

Procedure

An alloy is formed when two metallic elements are mixed together to form a substance which has the combined properties of the original metals. No chemical reaction has taken place.
Silver coloured coins are an alloy of nickel and tin.
Brass is an alloy of copper and tin.
Golden coins are an alloy of nickel, copper and aluminium.

1/ Add a ten grains of lead shot to a crucible. Lead is a soft, grey metal.
2/ Add two granules of tin to the crucible. Tin is a hard, shiny metal.
3/ Place the crucible in a pipe clay triangle on top of a tripod.
4/ Heat the crucible with tip of a blue Bunsen flame until both metals have melted and mixed.
DO NOT BREATH ANY FUMES FROM THE CRUCIBLE.
- Which metal melted first?
5/ Allow the crucible to cool for at least five minutes.
6/ Remove the disk of metal which has formed and describe its properties.



Result: The lead shot melted first, followed by the tin granules. The combined metals cooled to form a dull silver disk which was relatively easy to bend.

Conclusion: The lead and tin melted together to form an alloy with properties from both of the original metals.

Risk Level: Mild Hazard: PERFORM THIS EXPERIMENT IN A WELL VENTILATED ROOM.

STUDENT: ____________________

286

Indelible Chalk

Aim: To make chalk which won't rub off the board.

Equipment

Sugar
Beaker, 250ml
Stirring rod
Chalk
Paper hand towel

Procedure

1/ Add 200g of sugar to 200ml water, stirring until dissolved.
2/ Add several sticks of chalk.
3/ When the chalk ceases to release air bubbles, remove it from the water and allow to drain on the hand towel.
4/ Allow the chalk to dry for at least two days.
5/ Try the treated chalk on the black board.

Results: ____

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Conclusion: ____

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286

Indelible Chalk

Topics: Matter

Aim: To make chalk which won't rub off the board.

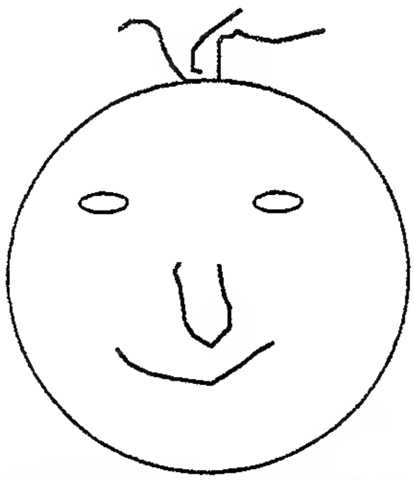
Equipment

Sugar
Beaker, 250ml
Stirring rod
Chalk
Paper hand towel

Procedure

1/ Add 200g of sugar to 200ml water, stirring until dissolved.
2/ Add several sticks of chalk.
3/ When the chalk ceases to release air bubbles, remove it from the water and allow to drain on the hand towel.
4/ Allow the chalk to dry for at least two days.
5/ Try the treated chalk on the black board.

For those inclined to practical jokes.
The chalk marks may be removed from the board with a wet cloth.



Result: The chalk writing on the board will not rub off with a duster, much like when you use the wrong pen on a white board.

Conclusion: The sugar forms crystals within the chalk. When drawn on the board the chalk has a higher adhesion strength and resists efforts to be removed with a duster.

Risk Level: Low Hazard: Except from the maths teacher when he finds out who doctored his chalk.

STUDENT: ____________________

287

Kinetic Corn

Aim: To demonstrate the Kinetic Theory of Matter.

Equipment

Pop Corn
Butter
Beakers, 250ml, two
Tripod
Bunsen
Evaporating basin, large
Fry pan

Preparation: Melt 50g of butter and pour over 100ml of pop corn kernels in an evaporating basin. Leave in a refrigerator until the butter hardens.

Procedure

1/ Watch the demonstration performed by the teacher, making notes on the properties of solids, liquids and gases and the behaviour of the particles in each of these states.

SOLID
Properties: ____________________

Particles are ____________________

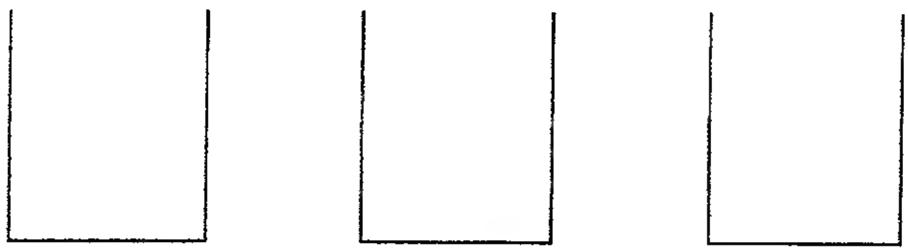
LIQUIDS
Properties: ____________________

Particles are ____________________

GASES
Properties: ____________________

Particles are ____________________

2/ In the containers drawn below draw particles in the solid, liquid and gaseous state.



Solid   Liquid   Gas

Results: ____________________

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Conclusion: ____________________

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____

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287

Kinetic Corn

Topics: Matter Kinetic Theory

Aim: To demonstrate the Kinetic Theory of Matter.

Equipment

Pop Corn
Butter
Beakers, 250ml, two
Tripod
Bunsen
Evaporating basin, large
Fry pan

Preparation: Melt 50g of butter and pour over 100ml of pop corn kernels in an evaporating basin. Leave in a refrigerator until the butter hardens.

Good Idea to have a large pan ready to make a batch of pop corn for eating.

Procedure

1/ Remove the pop corn "solid" from the evaporating basin. Point out that the particles of corn are fixed in place and so the solid holds its shape and is incompressible.

2/ Heat the "solid" in the evaporating dish until the butter melts. Demonstrate that the particles are no longer fixed and the pop corn is now a "liquid" which can be poured to and from a beaker.

3/ Pour the pop corn 'liquid" into a fry pan and continue heating. Students will note the behaviour of the corn particles as they pop forming a "gas".

Result: In solids, molecules are fixed in place by intermolecular bonds. In liquids, molecules are free to move past and around each other. In gases the molecules are freely flying apart.

Conclusion: The basic properties of solids, liquids and gases can be explained in terms of the motion of particles.

Risk Level: Mild Hazard: Beware of hot butter droplets as the corn pops (clear the bench first).

STUDENT:________________

Atomic Mass

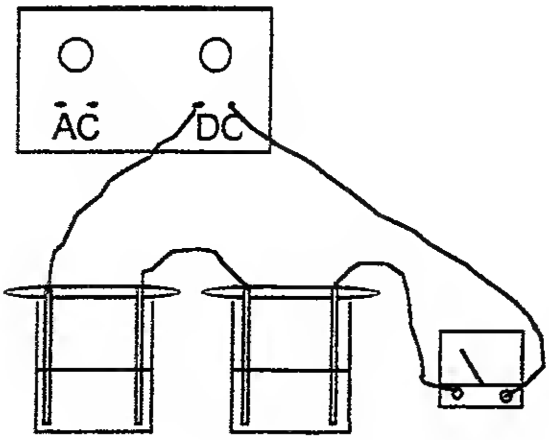
Aim: To determine the atomic mass of two elements.

Equipment

Power supply, 0-12V
Connecting wires,4
Ammeter, 0-1A
Alligator clips, four
Tin electrodes, two
Copper electrodes, two
Balance, 1mg sensivity
Copper Sulphate, 0.05M (1.25%), 50ml
Tin Chloride, 0.05M, 50ml
Paddle pop sticks, two
Test tube peg
Steel wool

Procedure

1/ Clean the electrodes with steel wool.
2/ Carefully weigh one copper electrode.__________
3/ Fasten the electrode to a paddle pop stick with an alligator clip which is then linked to the positive DC power terminal.
4/ Clip the second copper electrode to the stick and place both electrodes in a beaker with 5oml of copper sulfate.
5/ Carefully weigh a tin electrode.________
6/ Clip the tin electrode to a second stick. Connect the alligator clip to the second copper electrode.
7/ Clip a second tin electrode to the stick and place both electrodes in a beaker with 50ml of tin chloride.
8/ Connect the second tin electrode to the positive terminal of the ammeter and connect the negative terminal to the negative terminal of the power supply.
9/ Adjust the voltage until about 0.5Amps are flowing.
10/ After exactly 30mins, remove the first copper electrode, dry it 20cm above a bunsen and measure its weight. ______
10/ Repeat step 9 for the first tin electrode.______



Atomic Mass of Copper

$$= \frac{\text{Mass lost X current}}{0.00233}$$

= ____________

Atomic Mass of Tin

$$= \frac{\text{Mass loss X current}}{0.00233}$$

= ______________

Results: ____

____

____

Conclusion: ____

____

____

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Atomic Mass

Topics: Molarity Ions Electricity

Aim: To determine the atomic mass of two elements.

Equipment

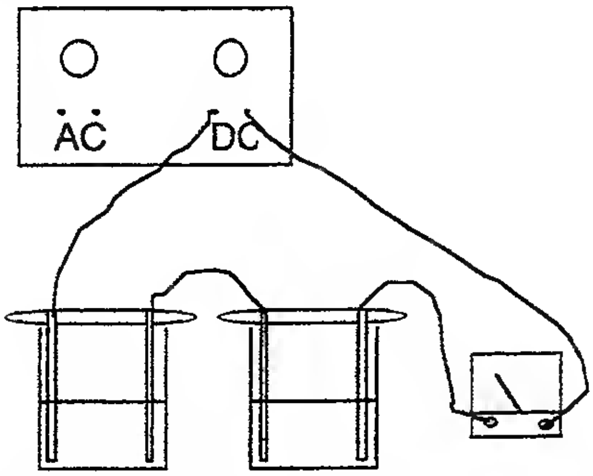
Power supply, 0-12V
Connecting wires,4
Ammeter, 0-1A
Alligator clips, four
Tin electrodes, two
Copper electrodes, two
Balance, 1mg sensivity
Copper Sulphate, 0.05M (1.25%), 50ml
Tin Chloride, 0.05M, 50ml
Paddle pop sticks, two
Test tube peg
Steel wool

Dissolve 11.3g of tin chloride in 50ml conc. hydrochloric acid then dilute to 1 litre.

Procedure

See the student copy for procedure. While the experiment proceeds take the students through the following calculation.

1 amp = 1 coulomb of charge per second.
In 30mins at 0.5 amps,30X60X0.5 coulombs of electrons have flowed ie 900 coulombs.
1 electron has a charge of 1.602×10^{-19} C
Therefore 900C =900 / $1.602 \times 10^{-19} = 5.62 \times 10^{21}$electrons
2 electrons are needed to ionise each metal atom so
2.81×10^{21} atoms have dissolved.
2.81×10^{21} atoms divided by Avogadros number (6.02×10^{23}) gives 0.00466 moles.
Dividing the mass lost from each electrode by 0.00466 moles will give the mass per mole ie. Atomic Mass
(To adjust for a different current multiply by, current / 0.5)



Result: The copper anode lost about 0.3g weight while the tin electrode lost 0.6g.

Conclusion: Since the same number of electrons passed through both cells the same number of atoms must have dissolved into ions and so tin must have an atomic mass twice that of copper. The calculations of mass per mole give figures within 10% of the actual atomic mass, 63.5 for copper and 118.7 for tin.

Risk Level: Mild Hazard: IM hydrochloric acid is mildly corrosive. Crystalline tin chloride may react violently with metal nitrates. Tin Chloride and copper sulfate may irritate the skin and are harmful if ingested.

STUDENT:_______________

289

Valency

Aim: To investigate the valency (or combining power) of some elements.

Equipment

Test Tube Rack
Filter Funnel
Test tubes, large, four
Filter paper
Sodium Sulfate,0.1M, 1.4%
Lead Nitrate, 0.1M, 3.3%
Silver Nitrate, 0.1M, 1.5 %
Potassium Carbonate, 0.1M, 1.4%
(use anhydrous salts)
Forceps (do not handle used filter papers)
Measuring cylinder, 10ml (rinse thoroughly between uses).

Procedure

Atoms react in simple whole number ratios to form molecules. This ratio is called valency. If compounds of equal concentration are used, they too will react in simple ratios of volume.

1/ Add 10ml of sodium sulfate solution to a test tube and then add 5ml of lead nitrate solution.
2/ Filter the precipitate, collecting the filtrate into a clean tube.
3/ Add another 5ml of lead nitrate. If a strong precipitate develops, repeat steps 2 and 3.
4/ Add 5ml of potassium carbonate solution to a test tube and then add 5ml of silver nitrate.
5/ Filter the precipitate, collecting the filtrate into a clean tube.
6/ Add another 5ml of silver nitrate. If a strong precipitate develops repeat steps 5 and 6.
7/ Add 5ml of potassium carbonate solution to a test tube and then add 5ml of lead nitrate solution.
8/ Filter the precipitate, collecting the filtrate into a clean tube.
9/Add another 5ml of lead nitrate. If a strong precipitate develops repeat steps 8 and 9.

Reaction	Volume of Sulfate	Volume of Lead	Ratio
1			
	Volume of Carbonate	Volume of Silver	
2			
	Volume of Carbonate	Volume of Lead	
3			

Results: ____

____

____

Conclusion: ____

____

____

____

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289

Valency

Topics: Molarity How Atoms Join Making Chemicals

Aim: To investigate the valency (or combining power) of some elements.

Equipment

Test Tube Rack
Filter Funnel
Test tubes, large, four
Filter paper
Sodium Sulfate,0.1M, 1.4%
Lead Nitrate, 0.1M, 3.3%
Silver Nitrate, 0.1M, 1.5 %
Potassium Carbonate, 0.1M, 1.4%
(use anhydrous salts)
Forceps (do not handle used filter papers)
Measuring cylinder, 10ml (rinse thoroughly between uses).

Procedure

Atoms react in simple whole number ratios to form molecules. This ratio is called valency. If compounds of equal concentration are used, they too will react in simple ratios of volume.

1/ Add 10ml of sodium sulfate solution to a test tube and then add 5ml of lead nitrate solution.
2/ Filter the precipitate, collecting the filtrate into a clean tube.
3/ Add another 5ml of lead nitrate. If a strong precipitate develops, repeat steps 2 and 3.
4/ Add 5ml of potassium carbonate solution to a test tube and then add 5ml of silver nitrate.
5/ Filter the precipitate, collecting the filtrate into a clean tube.
6/ Add another 5ml of silver nitrate. If a strong precipitate develops repeat steps 5 and 6.
7/ Add 5ml of potassium carbonate solution to a test tube and then add 5ml of lead nitrate solution.
8/ Filter the precipitate, collecting the filtrate into a clean tube.
9/Add another 5ml of lead nitrate. If a strong precipitate develops repeat steps 8 and 9.

Reaction	Volume of Sulfate	Volume of Lead	Ratio
1	5	5	1:1
	Volume of Carbonate	Volume of Silver	
2	5	10	1:2
	Volume of Carbonate	Volume of Lead	
3	5	5	1:1

Result: Sodium sulfate and lead nitrate react in a 1:1 ratio. Potassium carbonate and silver nitrate react in a 1:2 ratio. Potassium carbonate and lead nitrate react in a 1:1 ratio.

Conclusion: Lead and sulfate have equal valency. Carbonate has twice the valency of silver but an equal valency to lead. Therefore silver has a valency of 1, lead a valency of 2, carbonate a valency of -2 and sulfate a valency of -2.

Risk Level: Moderate Hazard: Lead nitrate is a cumulative toxin and exposure should be minimised. Silver nitrate is toxic and may cause black staining of skin.

STUDENT:____________________

290

Elastic Collisions

Aim: To compare the elastic efficiency of several balls.

Equipment

Tennis Ball
Cricket Ball
Baseball
Golf Ball
Squash Ball
Metre Rule

Procedure

1/ Drop each ball from a height of one metre onto a concrete surface and record the height to which it rebounds.

Each ball possesses Potential Energy being equal to:
Mass X gravity X height.

As the ball falls, the potential energy is converted to kinetic energy. On impact the kinetic energy is stored as elastic potential energy then released on the rebound as kinetic energy again. The ball will rise until all its kinetic energy is converted back into potential energy. Since gravity and the mass of the ball are constant only the original height and the rebound height need be compared.

- Which ball best stores elastic potential energy ?
- Which ball has the poorest storage of elastic potential?
- Where does the energy go that is lost?

Ball	Rebound Height
Cricket Ball	
Baseball	
Tennis Ball	
Golf Ball	
Squash Ball	

Results: ____

____

____

Conclusion: ____

____

____

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290

Elastic Collisions

Topics: Momentum Energy

Aim: To compare the elastic efficiency of several balls.

Equipment

Tennis Ball
Cricket Ball
Baseball
Golf Ball
Squash Ball
Metre Rule

For a more advanced treatment of impact see Impulse 92, Volume 1

Procedure

1/ Drop each ball from a height of one metre onto a concrete surface and record the height to which it rebounds.

Each ball possesses Potential Energy being equal to:
Mass X gravity X height.

As the ball falls, the potential energy is converted to kinetic energy. On impact the kinetic energy is stored as elastic potential energy then released on the rebound as kinetic energy again. The ball will rise until all its kinetic energy is converted back into potential energy. Since gravity and the mass of the ball are constant only the original height and the rebound height need be compared.

- Which ball best stores elastic potential energy ?
- Which ball has the poorest storage of elastic potential?
- Where does the energy go that is lost?

Result: The golf ball had the highest rebound while the squash ball had the lowest rebound.

Conclusion: The golf ball is best at storing elastic energy. The squash ball has the poorest elastic potential. The energy lost in the rebound is converted into heat and sound.

Risk Level: Low Hazard:

STUDENT:________________

291

Chain reaction

Aim: To demonstrate how a chain reaction occurs.

Equipment

Matches

Putty or play dough.

Procedure

Observe the demonstration carried out by the teacher. Remember, the demonstration is a representation in two dimensions. Most reactions occur in three dimensions.

- What is a chain reaction?

____

____

- What is the critical factor in the demonstration which determines whether a chemical chain reaction takes place?

____

-Nuclear reactions are triggered by decay particles (eg neutrons) colliding with a nucleus. Even in solids where the atoms are closely packed, most of each atom is space and a decay particle may pass through many atoms before striking a nucleus. What factor would increase the likelyhood of a decay nuetron striking another nucleus?

____

Results: ______________________________

____

____

Conclusion: ______________________________

____

____

____

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291

Chain reaction

Topics: Nuclear Physics

Aim: To demonstrate how a chain reaction occurs.

Equipment

Matches

Putty or play dough.

Procedure

IN A WELL VENTILATED ROOM

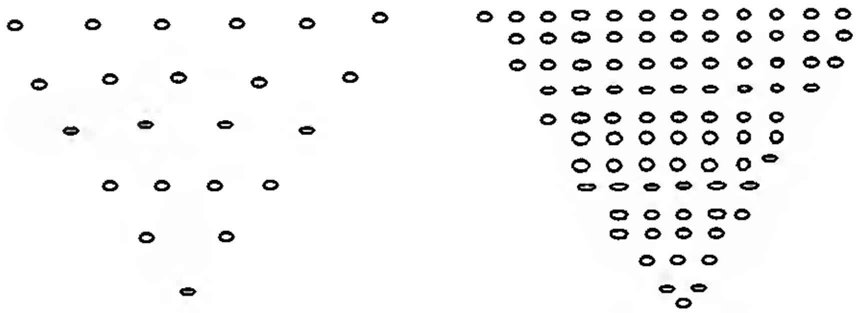
1/ Make two flat disks of putty about 8cm across.

2/ In the first disk, insert unused matches to make a triangular formation, each match head being about 1cm from its neighbour. Each side of the formation should be rank of 6 matches.

3/ In the second disk , insert unused matches to make a triangular formation, each match head being about 0.5cm from its neighbour. Each side of the formation should be rank of 12 matches.

4/ Light a match at the apex of the first formation.

5/ Light a match at the apex of the second formation.



Result: When matches are about 1cm apart the heat of one igniting is not sufficient to ignite a neighbour. When the matches are 0.5cm apart the first match ignites two which then ignite 4 and so on in an escalating chain reaction.

Conclusion: The decisive factor determining whether a chain reaction will take place is the density of reacting particles. Since much of an atom is space, decay particles can still escape small volumes of solid. In nuclear reactions there also has to be enough atoms so that decay particles are likely to strike another nucleus. This minimum number of atoms is called **Critical Mass**.

Risk Level: Moderate Hazard: TEACHER DEMONSTRATION ONLY. Phosphorus fumes from large numbers of burning matches is harmful if inhaled.

STUDENT:____________________

Casein

Aim: To make a simple plastic.

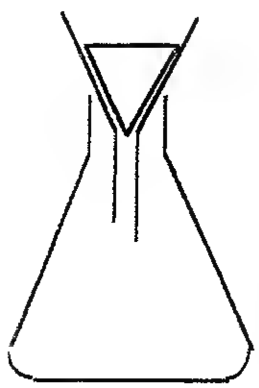
Equipment

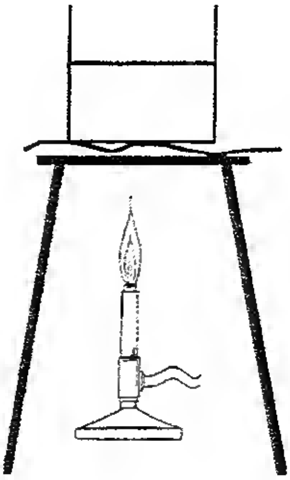
Milk, 100ml
Vinegar
Beaker, 250ml
Conical flask,250ml
Stirring Rod
Filter Funnel
Bunsen
Tripod
Gauze Square
Crepe Bandage, 10X10cm
Thermometer, 0-110C
Measuring cylinder, 10ml

Procedure

1/ Pour 100ml of milk into the beaker.
2/ Place the beaker on the gauze square and tripod.
3/ Heat with a bunsen, periodically measuring the temperature until the milk reaches 50 degrees centigrade.
4/ Slowly add 5ml of vinegar while stirring.
5/ Place the crepe material in the filter funnel and the funnel in the conical flask.
6/ Filter the milk. "Curds" will remain in the filter while the "Whey" passes through into conical flask.
7/ Remove the curds in the crepe and squeeze dry over a sink.
8/ Mold the curds into a shape and allow to dry for a few days.

- Your shape has now hardenned into a plastic called casein. Is the shape flexible?
- Hold a tip of your shape in a bunsen flame. If the plastic melts it is called a thermoplastic. If the plastic hardens it is called a thermosetting plastic.





Results: ____________________

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Conclusion: ____________________

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292

Casein

Topics: Organic Chem

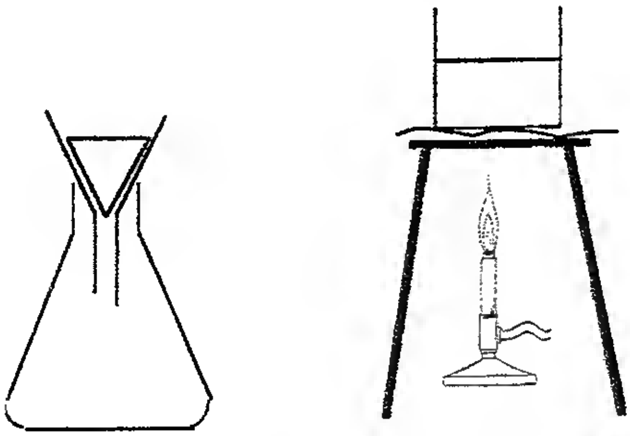
Aim: To make a simple plastic.

Equipment

Milk, 100ml
Vinegar
Beaker, 250ml
Conical flask,250ml
Stirring Rod
Filter Funnel
Bunsen
Tripod
Gauze Square
Crepe Bandage, 10X10cm
Thermometer, 0-110C
Measuring cylinder, 10ml

Procedure

1/ Pour 100ml of milk into the beaker.
2/ Place the beaker on the gauze square and tripod.
3/ Heat with a Bunsen, periodically measuring the temperature until the milk reaches 50 degrees centigrade.
4/ Slowly add 5ml of vinegar while stirring.
5/ Place the crepe material in the filter funnel and the funnel in the conical flask.
6/ Filter the milk. "Curds" will remain in the filter while the "Whey" passes through into conical flask.
7/ Remove the curds in the crepe and squeeze dry over a sink.
8/ Mould the curds into a shape and allow to dry for a few days.
- Your shape has now hardened into a plastic called casein. Is the shape flexible?
- Hold a tip of your shape in a Bunsen flame. If the plastic melts it is called a thermoplastic. If the plastic hardens it is called a thermosetting plastic.



Result: The curds harden into a flexible, rubber like plastic which hardens when heated.

Conclusion: Casein is a thermosetting plastic. Unlike other plastics casein is not a true polymer (long chains of molecules). Milk contains large molecules called proteins. Heat and the acid in vinegar denature the proteins so they are no longer soluble in water. The protein molecules tangle and clump forming curds.

Risk Level: Low Hazard: Lots of fun making rubber balls.

STUDENT:__________________

293

Nylon

Aim: To produce the polymer fibre, Nylon.

Equipment

Sebacoyl Chloride 2.2g
(or Adipoyl Chloride 1.7g)
1,6 Diaminohexane 2.2g
Dichloromethane, 100ml
Sodium Carbonate, 6g
Beakers, 250ml, two
Beaker, 400ml
Glass stirring rod
Forceps
Retort stand and clamp
Tripod.

Procedure

A solution of diaminohexane is poured over a solution of sebacoyl chloride to form a two layered liquid.

- Draw and label the appyratus used by the teacher.
- Describe how nylon is produced from the interface of the two liquids.
- How would you chemically describe Nylon?

Results: ____

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Conclusion: ____

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293

Nylon

Topics: Organic Chem

Aim: To produce the polymer fibre, Nylon.

Equipment

Sebacoyl Chloride 2.2g
(or Adipoyl Chloride 1.7g)
1,6 Diaminohexane 2.2g
Dichloromethane, 100ml
Sodium Carbonate, 6g
Beakers, 250ml, two
Beaker, 400ml
Glass stirring rod
Forceps
Retort stand and clamp
Tripod.

The reagents in this experiment are expensive.

Procedure

Perform Steps 1 to 3 in a fume hood.

1/ Dissolve 2.2g sebacoyl chloride in 100ml dichloromethane with vigorous stirring in a 250ml beaker.

2/ Dissolve 2.2g diaminohexane and 6g sodium carbonate in 50ml of water.

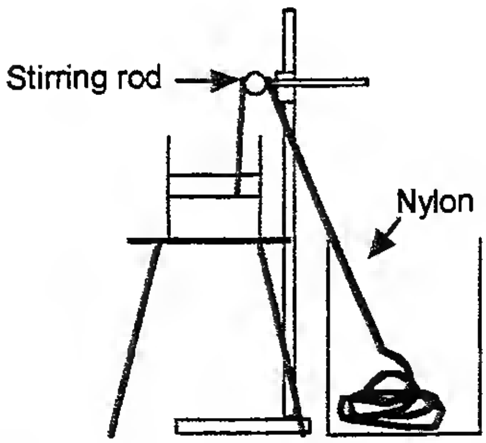
3/ Carefully pour the diaminohexane down the side of the beaker containing the sebacoyl chloride solution to form a a two layered solution.

4/ Fix the glass rod horizontally on the retort stand about 30cm above the bench.

5/ Place the layered solution on the tripod positioned below the horizontal stirring rod.

6/ Place the 400ml beaker beside the tripod.

7/ Use forceps to grasp the nylon at the interface of the two layers and carefully draw it over the stirring rod and down into the large beaker.



Result: A continuous strand of nylon is drawn from the interface and accumulates in the large beaker.

Conclusion: Nylon is a linear addition polymer formed from sebacoyl chloride and diaminohexane.

Risk Level: HAZARDOUS: TEACHER DEMONSTRATION ONLY. Sebacoyl chloride is corrosive and reacts with moisture in the air to form hydrogen chloride fumes (old bottles can explode from internal pressure). Diaminohexane is caustic and inflammable. Dichloromethane is flammable.

STUDENT:____________________

294

Green Plants?

Aim: To investigate why plants are green rather than red or blue.

Equipment

Corn seeds (40)
Plastic punnets, four
Clear wrapping plastic
Tinted plastic, 30X40cm, red, green and blue.

potting mix
beaker, 250ml
Sticky tape

Procedure

1/ Fill each plastic punnet with moist potting mix.
2/ Plant ten corn seeds in each punnet, 1cm deep and eveny dispersed.
3/ Pour 200ml of water slowly over each punnet.
4/ Wrap one punnet in a tube of clear wrapping plastic.
Wrap one punnet in a tube of red tinted plastic.
Wrap one punnet in a tube of blue tinted plastic.
Wrap one punnet in a tube of green tinted plastic.
5/ Place the punnets in a sunny position, giving each punnet 100ml of water every two days.
6/ After 14 days examine the corn plants, measuring the height of each.

Corn Height after 14 days (cm)

Plants	Sunlight	Red Light	Blue light	Green light
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Average				

Results: ____

____

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Conclusion: ____

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294

Green Plants?

Topics: Plants Scientific method

Aim: To investigate why plants are green rather than red or blue.

Equipment

Corn seeds (40)
Plastic punnets, four
Clear wrapping plastic
Tinted plastic, 30X40cm, red, green and blue.

potting mix
beaker, 250ml
Sticky tape

Procedure

1/ Fill each plastic punnet with moist potting mix.
2/ Plant ten corn seeds in each punnet, 1cm deep and evenly dispersed.
3/ Pour 200ml of water slowly over each punnet.
4/ Wrap one punnet in a tube of clear wrapping plastic.
Wrap one punnet in a tube of red tinted plastic.
Wrap one punnet in a tube of blue tinted plastic.
Wrap one punnet in a tube of green tinted plastic.
5/ Place the punnets in a sunny position, giving each punnet 100ml of water every two days.
6/ After 14 days examine the corn plants, measuring the height of each.

Corn Height after 14 days (cm

Plants	Sunlight	Red Light	Blue light	Green light
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Average				

Result: Plants in the clear plastic tube were green and tall. Plants in the red tube and blue tube were less vigorous. Plants in the green tube were very pale and stunted.

Conclusion: Plants receiving a full sunlight spectrum grew well while plants receiving predominantly red or blue light grew, but not as well. Plants receiving green light did not grow well. Therefore the pigment in plants which absorbs and uses light for photosynthesis does not absorb green light. Plants appear green because they reflect green light while absorbing other frequencies.

Risk Level: Low Hazard:

STUDENT: ____________________

295

Leaf Section

Aim: To prepare and examine a leaf cross-section under a microscope.

Equipment

Safety razor blades, two
Glass slide
coverslip
Dropper bottle of water
Microscope
Fresh plant leaf.

Procedure

1. Place the leaf over the glass slide.
2. Hold both razor blades together and with light pressure draw the corner of the blades across the leaf. A thin leaf section remains between the severed parts of the leaf.
3. Remove the main parts of the leaf.
4. Trim the leaf section to about 1cm in length.
5. Carefully turn the leaf section on its side with one razor.
6. Gently place a cover slip over the leaf section.
7. Place a droplet of water at the edge of the coverslip. The water will be draw around the leaf section by capilarity.
8. Examine the leaf section under the microscope at 100X magnification.
9. In the space below, carefully draw the internal structure of the leaf section.

Results: ____

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Conclusion: ____

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295

Leaf Section

Topics: Plants

Aim: To prepare and examine a leaf cross-section under a microscope.

Equipment

Safety razor blades, two
Glass slide
coverslip
Dropper bottle of water
Microscope
Fresh plant leaf.

Begonia or other indoor plants are best , being softer and thicker.

Procedure

1. Place the leaf over the glass slide.
2. Hold both razor blades together and with light pressure draw the corner of the blades across the leaf. A thin leaf section remains between the severed parts of the leaf.
3. Remove the main parts of the leaf.
4. Trim the leaf section to about 1cm in length.
5. Carefully turn the leaf section on its side with one razor.
6. Gently place a cover slip over the leaf section.
7. Place a droplet of water at the edge of the coverslip. The water will be draw around the leaf section by capilarity.
8. Examine the leaf section under the microscope at 100X magnification.
9. In the space below, carefully draw the internal structure of the leaf section.

Result: Several different layers can be discerned within the leaf section.

Conclusion: Cuticle and palisade layers should be easily discerned.

Risk Level: Mild Hazard: Count and issue the safety razors just before the students are ready to commence. Collect and count the razors as soon as the sections have been prepared.

STUDENT:____________________

296

Falling Target

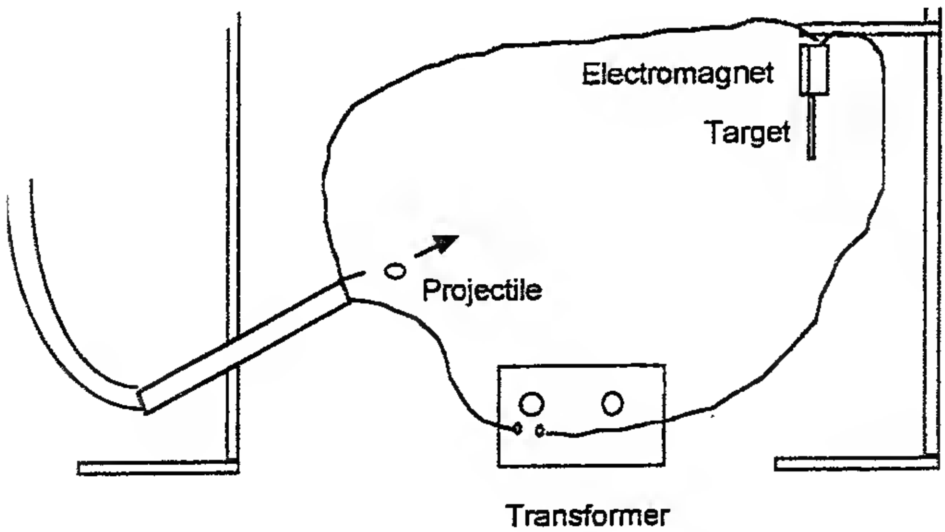
Aim: To demonstrate that objects fall at the same rate thereby eliminating the vertical component of motion.

Equipment

Retort Stands, 2
Clamps & Boss Heads, 2
Electromagnet
Power supply 2-12V
Connecting wires, 3
Steel Target plate, 5x5cm
Flexible tubing,40cm
Rigid tube,20cm
Marble projectile
Adhesive tape

Procedure

1/ Connect the flexible tube to the rigid tube
2/ Use the retort stands to set up the apparatus as shown in the diagram below.
3/ Use a connecting wire to link one terminal of the power supply to the electromagnet. Link the other magnet terminal to the mouth of the rigid tube with tape. Link the other power terminal to the mouth of the rigid tube. Link the two wires at the tube without blocking the tube mouth.
4/ Turn on the power to 6 Volts DC and suspend the target plate beneath the electromagnet.
5/ Place the marble in the rigid tube and aim at the target
6/ Aim the rigid tube at the the target.
7/ Blow rapidly through the flexible tube
8/ Change the height of the rigid tube, aim and fire again.
9/ Place the tube level with the target, aim and fire again.
10/ Repeat steps 5 to 9 with the wires touching across the the tube mouth so the marble will break the contact .



Results: ____

Conclusion: ____

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296

Falling Target

Topics: Projectiles Gravity Vectors

Aim: To demonstrate that objects fall at the same rate thereby eliminating the vertical component of motion.

Equipment

Retort Stands, 2
Clamps & Boss Heads, 2
Electromagnet
Power supply 2-12V
Connecting wires, 3
Steel Target plate, 5x5cm
Flexible tubing,40cm
Rigid tube,20cm
Marble projectile
Adhesive tape

Hint ; Check that the marble and the rig tube are a close fit.

Procedure

1/ Connect the flexible tube to the rigid tube.
2/ Use the retort stands to set up the apparatus as shown in the diagram below.
3/ Use a connecting wire to link one terminal of the power supply to the electromagnet. Link the other magnet terminal to the mouth of the rigid tube with tape. Link the other power terminal to the mouth of the rigid tube. Link the two wires at the tube without blocking the tube mouth.
4/ Turn on the power to 6 Volts DC and suspend the target plate beneath the electromagnet.
5/ Place the marble in the rigid tube and aim at the target
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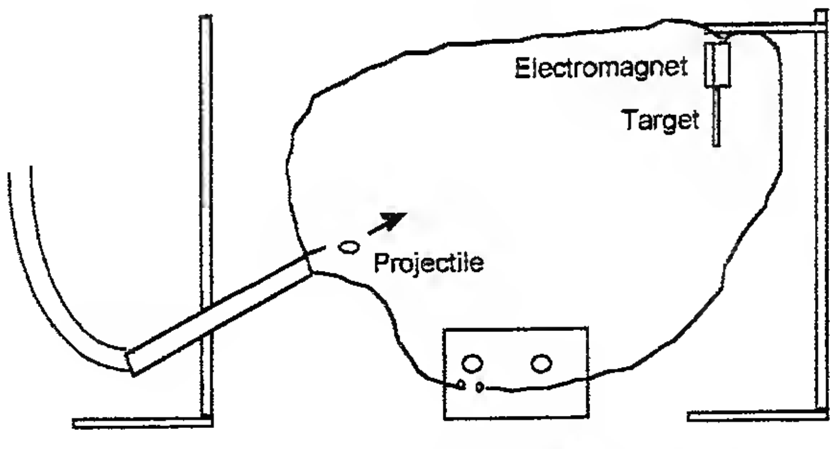

Result: The marble follows a curved path missing the target held by the magnet. When the marble breaks the contact wires the target plate falls. The marble always hits the falling target regardless of the firing height or angle.

Conclusion: The marble misses the fixed target since its path is altered by gravity. When the marble breaks the wire contacts at the mouth of the tube the marble and the target fall with equal acceleration due to gravity. When the marble reaches the horizontal position of the target it will also be at the same height as the target and so they strike.

Risk Level: Low Hazard; Use a projectile which does not gather too much velocity or the students will be tempted to shoot each other ie. a marble is better than a dried pea.

STUDENT:____________________

297

Rock Types

Aim: To classify rock samples as either sedimentary, igneous or metamorphic.

Equipment

Rock Samples:
Basalt
Shale
Sandstone
Schist
Granite
Gneiss

Procedure

Examine each rock sample.
Record in the table below whether the sample contains layers.
Record whether sample is hard or soft depending on if it is easily marked or grains removed by a finger nail.
Classify the samples as sedimentary, metamorphic or igneous based on the following data:
- Igneous rocks form from molten magma or lava and so are hard and lack straight layers.
- Sedimentary rocks are formed by weathered particles settling into layers which gradually compact. Sedimentary rocks have layers and are usually soft.
- Metamorphic rocks are sedimentary rocks which have been changed by extreme heat and pressure. These rocks often have thin compressed layers and though harder than the original rock, metamorphic rocks are not as hard as igneous rocks.

Rock	Hard/Soft	Layers	Classification
Sandstone			
Granite			
Gneiss			
Basalt			
Schist			
Shale			

Results: ____

____

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Conclusion: ____

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297

Rock Types

Topics: Rocks & Minerals

Aim: To classify rock samples as either sedimentary, igneous or metamorphic.

Equipment

Rock Samples:
Basalt
Shale
Sandstone
Schist
Granite
Gneiss

Procedure

Examine each rock sample.
Record in the table below whether the sample contains layers.
Record whether sample is hard or soft depending on if it is easily marked or grains removed by a finger nail.
Classify the samples as sedimentary, metamorphic or igneous based on the following data:
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- Metamorphic rocks are sedimentary rocks which have been changed by extreme heat and pressure. These rocks often have thin compressed layers and though harder than the original rock, metamorphic rocks are not as hard as igneous rocks.

Rock	Hard/Soft	Layers	Classification
Sandstone			
Granite			
Gneiss			
Basalt			
Schist			
Shale			

Result: Shale and sandstone are soft with layers. Schist and gneiss have fine layers and are harder. Granite and basalt have no layers and are very hard.

Conclusion: Shale and Sandstone are sedimentary. Schist and gneiss are metamorphic rocks while basalt and granite are igneous.

Risk Level: Low Hazard.

STUDENT:____________________

298

Weathering

Aim: To simulate weathering by heating and cooling.

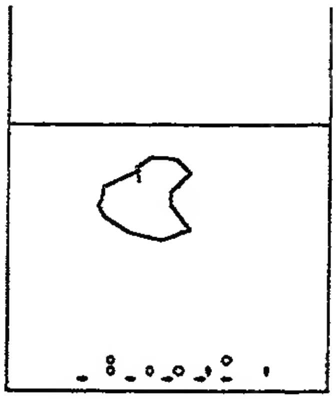
Equipment

Rock Sample (granite)
Tongs
Bunsen
Beaker, 250ml
Protective Eye Glasses

Procedure

1/ Fill a beaker with water.
2/ Light the Bunsen and put on the eye glasses.
3/ Grasp the rock with the tongs and heat it over the Bunsen.
4/ Plunge the rock into the water.
5/ Repeat the last two steps several times.

- What is happening to the rock?
- What is happening to the fragments produced?



Results: ____

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Conclusion: ____

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298

Weathering

Topics: Rocks & Minerals

Aim: To simulate weathering by heating and cooling.

Equipment

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Tongs
Bunsen
Beaker, 250ml
Protective Eye Glasses

Procedure

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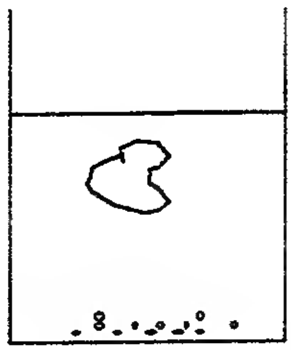
4/ Plunge the rock into the water.
5/ Repeat the last two steps several times.

- What is happening to the rock?
- What is happening to the fragments produced?



Result: Fragments of the rock break off in the water and settle to the bottom.

Conclusion: The hard granite rock expands during heating. When plunged into water the outer layers contract faster than the inner parts of the rock. As a result fragments of rock break off. The rock is being weathered by heating and cooling. The fragments are sedimenting in the water. Over time the sediments may build up and become compressed into sedimentary rock.

Risk Level: Moderate Hazard: Hot fragments of rock may fly off during heating and so eye protection is necessary.

STUDENT:____________________

299

Mystery Solution

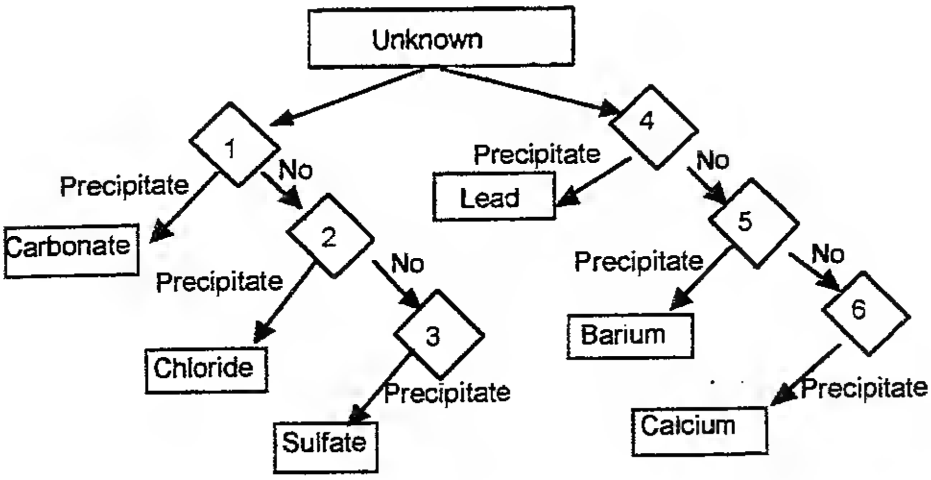
Aim: To identify the compound in unidentified solutions using a flow chart of tests.

Equipment

Test Tube rack
Test tube, medium, two
Labelled dropper bottles :
Copper Nitrate, 1%
Silver Nitrate, 1%
Lead Nitrate, 1%
Sodium Sulfate, 1%
Sodium Chloride, 10%
Sodium Hydroxide, 1%
Unknown 1
Unknown 2
Unknown 3

Procedure

1/ Add 20 drops of Unknown 1 to both test tubes
2/ Carry out the tests as indicated by the flow chart using the following key:
1/ Add 3 drops of copper nitrate.
2/ Add 3 drops of silver nitrate.
3/ Add 3 drops of lead nitrate.
4/ Add 3 drops of sodium chloride.
5/ Add 3 drops of sodium sulfate.
6/ Add 3 drops of sodium hydroxide.
3/ Having identified Unknown 1, thoroughly rinse the test tubes and repeat the proceedure to identify Unknown 2.
4/ Thoroughly rinse the test tubes and repeat the proceedure to identify unknown 3.



Results: ____

____

____

Conclusion: ____

____

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299

Mystery Solution

Topics: Solubility Scientific Method

Aim: To identify the compound in unidentified solutions using a flow chart of tests.

Equipment

Test Tube rack
Test tube, medium, two
Labelled dropper bottles :
Copper Nitrate, 1%
Silver Nitrate, 1%
Lead Nitrate, 1%
Sodium Sulfate, 1%
Sodium Chloride, 10%
Sodium Hydroxide, 1%
Unknown 1
Unknown 2
Unknown 3

Procedure

1/ Add 20 drops of Unknown 1 to both test tubes

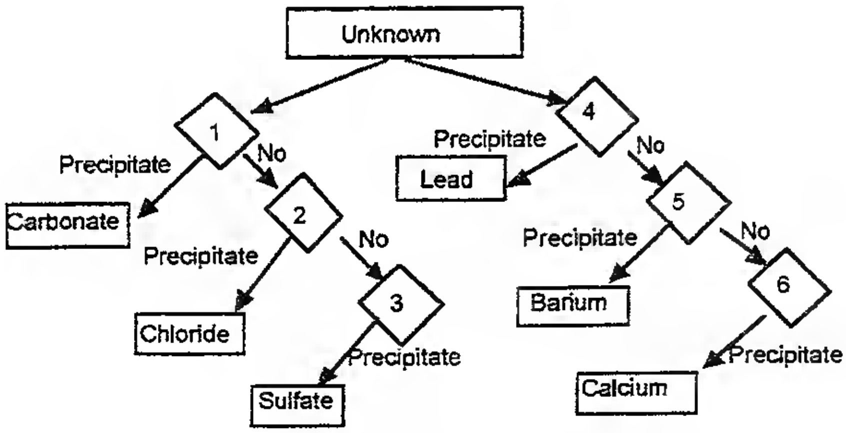
2/ Carry out the tests as indicated by the flow chart using the following key:

1/ Add 3 drops of copper nitrate.
2/ Add 3 drops of silver nitrate.
3/ Add 3 drops of lead nitrate.
4/ Add 3 drops of sodium chloride.
5/ Add 3 drops of sodium sulfate.
6/ Add 3 drops of sodium hydroxide.

3/ Having identified Unknown 1, thoroughly rinse the test tubes and repeat the proceedure to identify Unknown 2.

4/ Thoroughly rinse the test tubes and repeat the proceedure to identify unknown 3.

1/ Calcium Chloride, 1%
2/ Barium Chloride, 1%
3/ Calcium Sulfate, 1%



Result: Unknown 1 produces a precipitate in reactions 2 and 6. Unknown 2 produces a precipitate in reactions 2 and 5. Unknown 3 produces a precipitate in reactions 3 and 6.

Conclusion: Unknown 1 is calcium chloride.
Unknown 2 is barium chloride.
Unknown 3 is calcium sulfate.

Risk Level: Moderate Hazard: Lead and silver nitrate are toxic and should be handled with care. Silver nitrate causes black skin stains while lead nitrate is a cumulative toxin. All precipitates of the lead or silver reagents should be considered harmful if ingested. Sodium hydroxide is caustic and any contact with the skin or eyes should be treated by prolonged washing with water.

STUDENT: ____________________

300

Softening Water

Aim: To investigate "Hard" water and how it may be softened.

Equipment

Test tubes, medium, three
Test tube stoppers, three
Test tube rack
Hard water 1(1.1g calcium chloride, 1.7g sodium bicarbonate, 1 litre water).
Hard water 2 (1.7g calcium sulfate, 1 L water)
Hard water 3 (1.1g calcium chloride,1 L water)
Sodium Carbonate, 0.01M (0.1%) in dropper bottle.
Soap Solution (10g soap flakes dissolved in 1L water) in dropper bottle.
Measuring Cylinder, 10ml
Bunsen
Test tube peg.

Procedure

Water drawn from bores and wells often contains salts dissolved from rocks such as limestone. Calcium salts interfere with the lathering of soap. Water containing calcium is called "hard water". Hard water may be softenned by various methods depending on the type of calcium salt.

1/ Add 5ml of Hard Water 1 (Calcium Bicarbonate) to each test tube.
2/ Heat the second test tube until it boils gently for 1 minute.
3/ Add Sodium Carbonate dropwise to the third test tube until no more precipitate forms.
4/ Add ten drops of soap solution noting any change. Shake the the tube to see if a lather will form.
5/ Thoroughly rinse the test tubes.
6/ Repeat steps 1 to 5 for Hard Water 2 (calcium sulfate)
7/ Repeat steps 1 to 5 for Hard Water 3 (calcium chloride)

Water	Soap Lathering		
	Control	Boiled	Carbonate
Hard Water 1			
Hard Water 2			
Hard Water 3			

Results: ____

____

____

Conclusion: ____

____

____

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300

Softening Water

Topics: Water Ions Organic Chem

Aim: To investigate "Hard" water and how it may be softened.

Equipment

Test tubes, medium, three
Test tube stoppers, three
Test tube rack
Hard water 1(1.1g calcium chloride, 1.7g sodium bicarbonate, 1 litre water).
Hard water 2 (1.7g calcium sulfate, 1 L water)
Hard water 3 (1.1g calcium chloride,1 L water)
Sodium Carbonate, 0.01M (0.1%) in dropper bottle.
Soap Solution (10g soap flakes dissolved in 1L water) in dropper bottle.
Measuring Cylinder, 10ml
Bunsen
Test tube peg.

Procedure

Water drawn from bores and wells often contains salts dissolved from rocks such as limestone. Calcium salts interfere with the lathering of soap. Water containing calcium is called "hard water". Hard water may be softened by various methods depending on the type of calcium salt.

1/ Add 5ml of Hard Water 1 (Calcium Bicarbonate) to each test tube.
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4/ Add ten drops of soap solution noting any change. Shake the the tube to see if a lather will form.
5/ Thoroughly rinse the test tubes.
6/ Repeat steps 1 to 5 for Hard Water 2 (calcium sulfate)
7/ Repeat steps 1 to 5 for Hard Water 3 (calcium chloride)

Water	Soap Lathering		
	Control	Boiled	Carbonate
Hard Water 1			
Hard Water 2			
Hard Water 3			

Result: Boiling can soften water containing calcium bicarbonate. Sodium Carbonate precipitates calcium ions and softens all three types of hard water.

Conclusion: Boiling converts bicarbonate ions to carbonate ions causing precipitation of calcium carbonate. Sodium Carbonate is also known as washing soda since it softens hard water by precipitating calcium carbonate. Calcium ions can also be chelated in solution by complex ions such as EDTA. Gels containing anion exchange resins can also remove calcium ions.

Risk Level: Low Hazard:

CHEMISTRY

Matter

45 Crystal Forms
46 Crystal Forms 1
47 Crystal Garden
54 Distillation
67 Filtration
34 Chromotography
3 Absorbtion
285 Alloys
286 Indellible Chalk
118 Metho and Water
270 Dissolving
287 Kinetic Corn
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